THE RELEVANCE OF COUNTERMOBILITY FOR FORCE XXI

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE
STRATEGY

by

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This study examines the countermobility support requirement relevance for echelons brigade and below from the time period of Army of Excellence and Force XXI through the form of a comparative analysis. The thesis begins with an overview of development of countermobility doctrine and equipment during the Army of Excellence from 1985 to the early 1990s. Initially, development of doctrine and equipment was largely based on the Army's experiences during World War II.
Additionally, I will present current data that addresses countermobility requirements for Army Force XXI units as the results of a survey conducted with Engineer Officers of Command and General Staff College Officers class of 2000. This statistical analysis will highlight many of the current trends in the evolution of countermobility as a functional requirement for the Corps of Engineers as part of the transition to the battlefields of tomorrow.
Later, development of doctrine and equipment for Army of Excellence was largely designed around a threat based enemy that was forward deployed in a mature theater. In conclusion, the thesis compares current doctrine and equipment of the Army of Excellence to Force XXI doctrine and equipment designed for Force XXI.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

THE RELEVANCE OF COUNTERMOBILTY FOR FORCE XXI by MAJ Michael A. Dillard, USA, 106 pages.

This study examines the countermobility support requirement relevance for echelons brigade and below from the time period of Army of Excellence and Force XXI through the form of a comparative analysis. The thesis begins with an overview of development of countermobility doctrine and equipment during the Army of Excellence from 1985 to the early 1990s.

Initially, development of doctrine and equipment was largely based on the Army's experiences during World War II.

Additionally, I will present current data that addresses countermobility requirements for Army Force XXI units as the results of a survey conducted with Engineer Officers of Command and General Staff College Officers class of 2000. This statistical analysis will highlight many of the current trends in the evolution of countermobility as a functional requirement for the Corps of Engineers as part of the transition to the battlefields of tomorrow.

Later, development of doctrine and equipment for Army of Excellence was largely designed around a threat based enemy that was forward deployed in a mature theater.

Finally, countermobility doctrine and equipment has transitioned from a Cold War, threat based force to a capabilities based power projection force.

In conclusion, the thesis compares current doctrine and equipment of the Army of Excellence to Force XXI doctrine and equipment designed for Force XXI. Recommendations will be included when shortfalls are identified.

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<u>LIST OF ABBREVIATIONS</u>

AAN	army after next
ACE	armored combat earthmover
ADAAMS	area denial artillery munitions
AF XXI	army force XXI
AP	antipersonnel
APC	armored personnel carrier
AO	area of operation
AOE	army of excellence
AT	antitank
BDE	brigade
BCT	brigade combat team
BSC	brigade support company
CC	combat command
CCW	certain conventional weapons
CEV	combat engineer vehicle
CGSC	command and general staff college
CSS	combat service support
DCX	division command exercise
EAD	echelons above division
ETO	European theater of operations
FASCAM	family of scatterable munitions

LIST OF ABBREVIATIONS

FM	field manual
HHC	headquarters and headquarters company
LOC	line of communication
MASH	mobile surgical ambulatory hospital
MG	major general
MICLIC	mine clearing line charge
MOPMS	modular pack mine system
MSR	main supply route
PAM	pamphlet
RAAMS	remote anti-armor mine
SEE	small emplacement excavator
SWA	Southwest Asia
TBM	tactical ballistic missile
TRADOC	training and doctrine command
WAM	wide area munitions
WWII	World War II

CHAPTER 1

INTRODUCTION

The Problem

The purpose of my thesis is to determine, by means of comparative analysis, whether the United States Army's transition from the Army of Excellence to the new Army Force XXI design causes a potential shortfall in countermobility. In its quest to evolve to an Army that is more mobile, more agile, and can rapidly deploy, the issue arises as to whether the force structure retains the personnel and equipment necessary to perform the required countermobility tasks.

Countermobility, as defined by FM 5-102, dated March 1985, is divided into mine warfare and obstacle development, each with an ultimate goal of delaying, stopping, or channeling the enemy. In addition, FM 90-7, dated September 1994, adds that countermobility is a component of combat power. In terms of impacting the dynamics of combat power, countermobility efforts contribute to decisions in engagements and battles by degrading the enemy's maneuver, thereby, contributing to more favorable conditions for engagement with fires. Marine Corps doctrine similarly defines countermobility as "those actions that impede movement of the opposing forces," and explains that such effort "can enhance the effectiveness of friendly fires and can cause the enemy losses in personnel, equipment and time" (Krueger 1998, 4).

Countermobility is accomplished by either physically or psychologically affecting the enemy force so that its ability to maneuver is impeded even more than the difficulties posed by the existing media of the battlespace. Techniques and procedures for countermobility fall into three classes of efforts: (1) physical alteration of existing battlespace to cause greater difficulty for movement, for example, digging of an antitank ditch, blowing or digging of a road crater, digging a pit along an infantry approach, or demolition of a bridge, (2) construction of barriers to impede movement, such as, log obstacles, abitis, dragon's teeth, boulders, walls, wire obstacles, and (3) mine warfare. The first two categories render additional physical impediment to maneuver, with the last rendering psychological and physical impediment to maneuver. Mine warfare combines the factors of lethality and uncertainty to cause minefields to be effective obstacles as they psychologically impact on maneuver of forces in their proximity. Because countermobility is a component of combat power, countermobility efforts will contribute to the decision in engagements and battles by degrading the enemy's maneuver, thereby, contributing to more favorable conditions for engagements with fires (Krueger 1998, 6).

Background

Prior to the Army of Excellence warfighting theory was the concept of Active Defense. The Active Defense doctrine was defined as a defense oriented to defeat the enemy by attriting his combat power as he attacked. Countermobility and mobility were the two primary missions of Active Defense. Countermobility missions were necessary to slow the enemy advance and canalize him into killing zones. It is during this time that the U.S. Army focus changed from defeating the enemy through an active defense, to defeating the enemy through the use of offensive operations to destroy the enemy's forces. This theoretical concept became the basis of the Army of Excellence warfighting doctrine (Cain 1984, 1).

Army of Excellence

The Army has transitioned from a Cold War, threat based force to a capabilities-based power projection force. "The characteristics of this new operational environment are precise, simultaneous, and multidimensional operations occurring across a nonlinear, distributed battlespace" (Flowers, Lowrey, and Porter 1998, 1). These changes in the Army's operational environment lead to adjustments to the engineer force. These operational changes consist of transitioning from a forward-deployed force in mature theaters to a power-projection force inserted into underdeveloped theaters often lacking infrastructure. Combat forces are oriented toward operations across a larger area of the battlespace while the threat becomes more technologically sophisticated with the availability of affordable weapons and smarter munitions.

Today's engineer forces are equipped and organized to support the Army of Excellence and, when required to, fight as infantry. Within the heavy division, engineer battalions are organized into a brigade of three battalions, each battalion habitually supporting the same maneuver brigade. These hard working battalions have performed well, but need to be modernized to keep pace with and be as survivable as the maneuver force, and gain a digital presence on the battlefield. The materiel systems presented in this thesis support the Army of Excellence and now lead into the Army Force XXI (Hackworth 1998, 1).

Army XXI

The primary mission of the engineer elements organic to the Army XXI Heavy Division is to provide mobility and limited countermobility support to the division's maneuver brigades, limited mobility and countermobility to other forces within the division as required, command and control of engineer units at engineer battalion and below, and staff planning and supervision of engineer operations at division level (Hackworth 1998, 1).

The Army Force XXI division has three major changes in engineer structure compared to the current Army of Excellence division:

1. An engineer staff element is part of the division headquarters and headquarters company (HHC) versus the current separate division engineer brigade headquarters.

2. An engineer battalion is assigned to each brigade combat team (BCT) in the division--rather than being assigned to the division engineer brigade headquarters as it is today.

3. All combat service support (CSS)(less medical) for the engineer battalion is provided by the base support company (BSC) of the BCT forward support battalion--versus

the current engineer battalion with its own CSS (Flowers, Lowrey, and Porter 1998, 3).

Although Army Force XXI is smaller, more lethal, more agile, and more deployable than the Army of Excellence concept of fighting, the Army has postured itself to be totally offense oriented with minimal requirements for countermobility. The Army Force XXI answer to the lack of countermobility is scatterable mines systems such as the volcano (both ground and air), area denial artillery munitions or remote antiarmor mine (ADAAM/RAAMS), and Raptor Intelligent Combat Outpost. (Raptor detects, classifies, and engages heavy and light tracked and wheeled vehicles as a combined hand emplaced-wide area munition). Further, Army Force XXI design does not allow for a deliberate defense with its current assigned task organization mine systems at the brigade level (tactical) and will require echelons above division (EAD) to construct a deliberate conventional minefield defense. Army of Excellence divisional engineers emplaced deliberate defenses with their organic assets (combat engineer platoons). The following brief historical example will show the engineer involvement during World War II and how countermobility contributed towards the outcome of the war.

History

During World War II, "the Russians laid in excess of 200 million mines throughout the war with Germany. In the great tank battle at the Kursk alone, they are reputed to have prepared minefields with a density of 4,000 mines per mile of front" (Sloan 1986, 3).

This particular vignette of World War II history was reported to have contributed to almost thirty percent of the Allied tank casualties through mines alone.

Major General George S. Patton considered that, of all the weapons used against armored units, mines were the greatest cause for concern.

> Casualty figures support General Patton's view of mines. One estimate places the percentage of U.S. armor lost from mine attack at seventy percent of the total of all losses from enemy action. French experience in Indo China shows an even higher figure of eighty-five percent of their tank losses being specifically attributed to Communist mines. (Sloan 1986, 5)

Thus, it can be argued that when countermobility (mine-warfare) is employed in great depth and density, maneuver will be reduced, if not terminated. Also, when countermobility was employed in depth, it contributed to the success of the defensive units.

Currently, Army Force XXI does not completely divorce itself from the need for the deliberate defense. Instead, Army Force XXI has pushed the requirement toward the National Guard and Army Reserve engineer units. An implied task is the substantial habitual combined arms training with the Active Component, National Guard and Army Reserve. This will impose command and control issues not discussed in detail. Who will coordinate and supervise these echelons above division (EAD) assets operating in and around the brigade combat team (BCT) area of operations (AO)? Specifically, there is no longer an active engineer brigade headquarters to task organize a National Guard or Army Reserve engineer group to coordinate and execute the needs and requirements of the BCT.

So while the Army Force XXI engineer force structure designs seem to suggest that the need for countermobility will remain, that crucial task is being relegated to Reserve component and National Guard engineer units to command and control and ultimately to execute.

Thus, Army Force XXI units will continue to require countermobility assets for success on the battlefields of tomorrow.

Assumptions

Prior to examining the suitability of countermobility as part of the Army Force XXI force package in detail, several assumptions must be made. First, the need or requirement for countermobility as part of the overall military operation has not changed since World War I. Second, countermobility as a component of combat power will exist and must be addressed on the digitized battlefield. Third, countermobilty will be represented on the modern and future battlefield in the form of the family of scatterable munitions (FASCM). Finally, in the past the employment of FASCAM was battle-tracked at the brigade level, will now be battle-tracked and command and controlled by battalion headquarters or the Reserve or National Guard engineer units which currently lack the necessary expertise for personnel and command and control.

Without countermobility, friendly maneuver forces can expect great difficulty as they attempt to degrade the enemy's combat power and maneuver. The resulting effect becomes less favorable conditions for engagements with fires and potentially greater risk to friendly forces that are now "naked" to the enemy's attack.

Limitations

Historical information in this thesis will be from World War II to the present. The historical information will attempt to highlight the significance of countermobility during WWII, Airland Battle and Army of Excellence. The thesis will explore the conceptual ideas based on the Army Force XXI design.

The thesis will primarily focus on countermobility systems available to echelons below division and how they are employed. The thesis will also compare systems available and how they are employed between two distinct periods: Army of Excellence and Army Force XXI.

Finally, the thesis will present findings from an Engineer Utilization Survey administered to the CGSOC engineer students of academic year 1999-2000.

Delimitations

The proposed study will only focus on Combat Engineering and not Topography Engineering or General Engineering. Specifically, countermobility will be discussed through doctrine, definitions, and historical examples. Mobility and survivability will only be discussed to show its balance as a major battlefield mission when coupled with countermobility.

The general study for this thesis will focus on Army of Excellence and Army Force XXI.

Significance of the Thesis

The significance of this thesis is to determine, by means of comparative analysis, whether, the United States Army's transition from the Army of Excellence to the Army Force XXI design causes a potential shortfall in countermobility. If potential shortfalls exist in the Army Force XXI design, recommend changes to correct or mitigate the shortfall.

The reorganization of the engineer force structure within the Army Force XXI Division will cause changes to our ability to accomplish traditional engineer missions. The Army Force XXI Division's engineer assets will focus almost entirely on mobility operations with a limited capability for countermobility and survivability missions. Countermobility and survivability, as well as other functions will have to be accomplished by EAD engineer units.

Echelons above division (EAD) must be capable of providing engineer support to augment the limited countermobility and survivability capabilities in the brigade combat team (BCT). The EAD engineer battalions must be highly flexible, modular and deployable.

It is debatable whether or not force designs have adequately addressed the need for countermobility in the Army Force XXI organizational structure.

CHAPTER 2

SURVEY OF LITERATURE

Periodicals

James Allen's review of Army Force XXI organizations in the Professional Engineer Magazine, *Engineer*, November 1998, addresses the changes in which Army Force XXI division engineers will operate doctrinally based on organizational changes in the Army Force XXI design. *Engineer*, compares engineer structure for the Army of Excellence and Army Force XXI. The major changes affecting doctrine are division engineer staff element, the division engineer battalion, echelon above division (EAD) engineer support, and CSS operations. Although James Allen's comparison of engineer structure for the Army of Excellence transitioning to the Army Force XXI supports a more lethal and more agile force structure, it does not address the issues of losing the Engineer Brigade Headquarters and its impact toward the completion of the mission. As seen in World War II and Desert Storm, the Engineer Brigade Headquarters was required to command control the additional engineer units supporting the division. Allen fails to incorporate the lessons learned from both World War I and Desert Storm. Another potential problem he fails to address will be the centralized logistical support. This implies that an armored or infantry brigade will have parts available for the older engineer equipment such as the AVLB, AVLM, ACE, mine detectors, and Volcanos, etc.

John R. Brinkerhoff review of the Brigade-Based New Army in the U.S. Army War College Quarterly, *Parameters*, Autumn 1997, address the changes resulting from the new armored brigade being smaller, but more lethal. It also asserts that the current armored division is not as large as its World War II predecessor, but has much more combat potential. Additionally, the proposed new armored brigade would have about one-third the strength but almost one and a half times the capability of the current armored division. The Army Force XXI armored brigade is becoming smaller and more lethal. However, Army Force XXI engineers lethality remains the same due to a lack of monetary support. *Parameters*, suggests that all forces should be smaller and more lethal. Although John Brinkerhoff's provides an excellent analysis of the New Brigade-Based Army, he also fails to carry the lessons learned from World War II and Desert Storm. As stated earlier, both conflicts required additional engineers not organic to the brigade. He also fails to mention that even though the force is trimmer and more lethal and more agile, the division footprint has increased and will require additional engineers to provide support to the division. He also failed to take into account that if a maintenance issue arises with the smaller force, there is no float system or additional equipment available.

Government Documents

The most informative government document for countermobility is Field Manual (FM) 5-102, dated March 1985. Although somewhat outdated, this manual whose purpose was to integrate countermobility into the overall AirLand Battle structure, provides excellent definitions, concepts, and planning considerations for implementing on today's modern battlefield. FM 100—5, dated June 1993, sets the conditions for the "big picture," and doctrine for the full dimensions of the battlefield in a force-projection environment. Even though the big picture is provided within FM 100-5, it fails to address the importance of robust command control headquarters to first support the division staff, and second command and control organic and augmented elements supporting the higher headquarters.

The Principles of War lists the tenets of AirLand Battle doctrine, all of great importance. In particular, mass, the effects of overwhelming combat power at the decisive place and time can be supported through countermobility. Mobility and survivability together as combat functions deny the enemy the ability to sufficiently maneuver against friendly forces. In simple terms, mobility simply means to maintain the momentum through breaching or bypassing the enemy defenses or enemy forces. Survivability means a stagnate defense and you will not be moving forward until you have rebuilt your combat power to allow you to continue operations. Countermobility allows you to prepare the defense while continuing to maneuver against the enemy.

FM 90-7, dated September 1994, gives two interesting historical vignettes in chapter 1 on the use of obstacles. The first vignette is during World War II, which shows the results of an obstacle not covered with fires. The second vignette is during the Korean War, which shows the lethal effects of an obstacle when a unit integrates fires and obstacles. Both vignettes represent the potential of an obstacle being emplaced to hinder the enemies maneuver. With situational (FASCAM) obstacles being introduced into the Army Force XXI force structure and smaller force, who will cover and track the status of these obstacles. The Engineer Brigade Staff element will be overtasked if a major conflict erupts. Again the vignettes highlight the importance of an Engineer Brigade Headquarters.

Army Joint Vision 2010, dated 1995, the vision for future warfighting, embodies the improved intelligence and command and control available in the information age and goes on to develop four operational concepts: dominant maneuver, precision engagement, full-dimensional protection, and focused logistics. Full-dimensional protection is the only operational concept that addressed countermobility.

The primary prerequisite for full-dimensional protection will be control of the battlespace to ensure our forces can maintain freedom of action during deployment, maneuver and engagement, while providing multilayered defenses for our forces and facilities at all levels.

The other three operational concepts focused on achieving mass without the use of large numbers or massed forces. But, by means of information superiority and advances in technology, massed desire effects will be achieved through the tailored application of joint combat power.

Army Joint Vision 2010 full-dimensional concept is excellent if facing another foe that possesses the same capabilities. Army Joint Vision 2010 will give us an accurate account of the enemy's activities, but will not predict his next advance. Realizing that the enemy has a vote in what he will do next, it will force the U.S. Army to go back to basics. As seen in Desert Storm after an intense air campaign, ground troops were still required to sweep across the plains of Southwest Asia (SWA) to clear or root out the enemy.

Books

Several secondary sources were used to conduct this research. *Mine Warfare on Land*, published by Lieutenant Colonel C. E. E. Sloan, was one of the most important sources for information. In LTC Sloan's book, he begins by talking about the beginnings of mine warfare and concludes with the present state of the mines. "Mines are relatively inexpensive, and can be laid in advance of combat, allowing the most economical use to be made of scarce engineer resources" (Sloan 1986, v).

Sloan ultimately argues that mine warfare has substantially developed into both the components of lethality and uncertainty that make minefields effective obstacles.

Although Sloan gives an excellent account of future mine development, he does not address the importance of command and control. In particular, who will track and coordinate the changes to these new and innovative systems that the Army Force XXI will emplace on the digitized battlefield? Also, while the munitions or mines are more lethal, the force is smaller and will require a multi-dimensional individual or element capable of command and controlling its capabilities to maximize its effects.

Unpublished Dissertations, Thesis, and Papers

There are four primary sources that were used for this category; a White Paper "Prioritization Paper for Engineer Future Capabilities," "Engineer and Mine Warfare Modernization Plan," a thesis for Command and General Staff College and a Strategy Research Project for the U.S. Army War College. The white paper "Prioritization Paper For Engineer Future Capabilities," by Major General Robert B. Flowers is focused on the near term work priorities for the Engineer School in order to develop the proper engineer capabilities that will be needed by U.S. Army. As stated in the paper, it is not intended to provide solutions but address areas of concern for the engineer force.

The second paper, "Engineer and Mine Warfare Modernization Plan," by Colonel David H. Hackworth, details engineer development efforts into the first decades of the 21st Century. It is the road map that will transition the Army of Excellence to Army Force XXI and then into the Army After Next (AAN).

"Mobility Support of Offensive Maneuver," by Major Francis Marion Cain III is a good source that provided excellent insight into the mobility support for the maneuver force. The study examined the mobility support necessary to conduct offensive maneuver at the tactical and operational levels of war. Throughout the thesis, mobility and countermobility were parallel in support of each other of offensive maneuver.

"Countermobility for the Army After Next," by Colonel Daniel W. Krueger, examines AAN operations and addresses why countermobility will be significant and how this battlefield function should be addressed integrally with the technological, physical, and doctrinal development that will forge the Army's ability to rapidly maneuver and to strike with precision.

Each of these sources confirm the requirement of Army Force XXI engineers to be capable to provide countermobility support to the maneuver force. They all address the issue of coordinating with echelons above divisional engineer support to complete the mission. However, they do not address lessons learned and how we are changing doctrine based on what an enemy could look like in the future and not based on historical accounts. As the U.S. Army continues to lead its foes in technology, it must assume that future foes will fight in a determined and persistent manner regardless of their technological level.

CHAPTER 3

RESEARCH METHOLOGY

Introduction

The research methodology for this thesis will be presented with a two-tracked method approach. The two approaches will be achieved through historical case studies and an Engineer Utilization Survey administered to the CGSOC engineer students of academic year 1999-2000.

The case studies will make an attempt to establish that history has proven that the U.S. Army doctrine lacks the sufficiency to sustain the current force during that particular time period. The case studies will also show that history is a cruel master. In addition, the case studies support that the U.S. Army improvised doctrine during combat operations.

The Engineer Utilization Survey of combat engineer officers with divisional and brigade combat team experience will represent the majority of answers and input into the survey. The survey also shared the conclusion that Army Force XXI has not allowed or demonstrated a need for countermobility support for the force.

The two-tracked approach will show the shortcomings of countermobility and history alone do not work.

Background

The first Field Manual (FM) published for a countermobility operation was FM 5-102 dated 1985. Although this was the first U.S. Army FM published for countermobility, the mine and countermobility operations existed as far back as the 18th and 19th Century.

In 1917, the British Tank Corps achieved a surprise victory over the Germans and the formation of mechanized warfare had been laid. "An effective means of dealing with these new and terrifying hardships had to be found, and the ever resourceful German troops developed a suitable counter: the mine" (Sloan 1986, 1).

As stated earlier, in 1918, German troops developed the mine, the most potent conventional weapon seen on the battlefield, as a counter-measure against the tank--the visible symbol of the arrival of the mechanized war. With its introduction the role of countermobility was significantly increased and the battlefield imperative of a strong defense took on even greater meaning (Sloan 1986, 1).

Obstacles can significantly enhance the effectiveness of our fires and our ability to win the battle.

Existing obstacles are those natural, cultural, and structural restrictions to movement that are a part of the terrain when battle planning begins. They can be natural for example; lakes and mountains, or they can be cultural such as towns or railroad embankments.

Reinforcing obstacles are constructed, emplaced, or detonated to knit together, strengthen, and extend existing obstacles. Imagination, time, manpower, or logistic constraints only limit reinforcing obstacles. Some examples of reinforcing obstacles are installing a minefield, blowing a road crater, or constructing a log crib.

Mines have generally been the most effective types of obstacle because they inflict losses on the enemy, and their use is highly flexible. The Family of Scatterable Mines (FASCAM) vastly increases this flexibility, making the creation of rapid minefields possible.

FASCAM, as described in FM 5-102, dated March 1985, gives friendly forces a capability to deny threat mobility anywhere on the battlefield. The use of scatterable minefields should be carefully planned and executed so that friendly mobility during future operations is not impeded (Field Manual 5-102, 29).

Planning for scatterable munitions was conducted within the Army of Excellence engineer brigade headquarters, while execution was delegated down to the Army of Excellence engineer battalion. Army Force XXI cuts the divisional engineer brigade headquarters from the force structure, delegating the responsibility to plan and execute scatterable munitions to the engineer battalion headquarters. The additional missions for the engineer battalion headquarters also include coordination with echelons above divisional (EAD) engineer units for additional countermobility tasks.

Army Force XXI division engineers are structured to provide only minimal obstacle creation and reduction capabilities. Any additional engineer support needed by the Army Force XXI division, such as bridging and heavy construction equipment, must come from EAD engineer forces. The EAD engineer support will come mainly from the Reserve Components of the U.S. Army Reserve and Army National Guard (Flowers, Lowrey, and Porter 1998, 4).

EAD engineer support will require an engineer headquarters element to command and control its efforts within the Army Force XXI battlespace. Additionally, extensive liaison capability will be required to effectively integrate EAD engineers with the Army Force XXI division. Many challenges will arise as we integrate Reserve Component EAD engineers with Army Force XXI division engineer training. Particular challenges will be, situational awareness, personnel status, equipment availability and readiness, and current location on the battlefield. Countermobility operations will be hindered as a result of additional time that will be required to integrate the reserve component with the active component.

EAD engineer supports to the Army Force XXI division will include terrain visualization, supplemental obstacle-reduction capability, mobility support through restrictive terrain, emplacement of deliberate defenses, and force protection. Additionally, EAD engineers will construct, repair, and maintain combat trails, LOC facilities, routes, bases, and forward aviation support sites (Flowers, Lowrey, and Porter 1998, 5).

Today's countermobility systems are considerably more versatile, more lethal, and situationally dependent. This is primarily true because today's countermobility systems can rapidly be employed with minimal manpower compared to the Army of Excellence concept. Mine warfare however, has substantially developed in ways contributing to both the components of lethality and uncertainty that make minefields effective obstacles through the use of scatterable mine systems. Although now more lethal and more agile, the integration of EAD engineer units will continue to challenge the Army Force XXI as it transforms from the Cold War to Army Force XXI, as a result of its training readiness in comparison to active component units.

As mentioned in the introduction, countermobility is a component of combat power. In terms of impacting the dynamics of combat power, countermobility efforts contribute to the decision in engagements and battles by degrading the enemy's maneuver, thereby, contributing to more favorable conditions for engagements with fires (Krueger 1998, 5). The following two case studies examine the nature of engineer operations in Europe during World War II, and in Southwest Asia (SWA) during Operation Desert Storm.

Case Study Introduction

The two following case studies, World War II and Operation Desert Storm represents a sampling of how countermobility doctrine changed from its intended doctrine for the particular operation. The case studies show that doctrine was present at the initiation of the conflict, but was improvised during combat operations.

Case Study #1--World War II

This case study examines engineer support in the European Theater of Operations (ETO). World War II also marked the largest engineer force ever fielded. Over 600,000 soldiers swelled the Corps of Engineers to record numbers between 1939 and 1945. Armored divisional engineers, augmented by corps and army engineers, supported World War II's fast moving "tankers." World War II validated "that the organic armored engineer. . . [facilitated} maneuver to the point. . . [of} action." (U.S. Armor School 1950, 25)

As First and Third Army raced across Europe, mobility requirements were obvious. However, once terrain had been seized, retaining that ground often required countermobility efforts. Organic engineers alone could not accomplish the task of retaining terrain with their own internal assets because of the large area of operation that the higher headquarters were operating in and around. Corps Combat Engineer Regiments were too rigid to conduct both combat and combat support missions. Corps Combat Engineer Regiments were tasked organized to either support combat or combat support missions, but not both. Thus replaced by a more flexible group headquarters, which would control from two to six combat engineer battalions, and various separate companies.

Engineer Support Operations

World War II engineers faced the same challenges presented in Vietnam and Bosnia: severely restricted terrain, extensive hydrology, war torn infrastructure, and serious mine threats. As such, in armored divisions, the inability of armored vehicles to negotiate weak bridges, obstacles, and minefields placed increasing emphasis on the tactical role of the organic engineer units (U.S. Armor School 1950, 14).

Divisional armored engineer battalions were organized into four combat engineer companies and a treadway bridge company. This organization supported a division of two tank regiments and one mechanized infantry regiment. Most World War II armored divisions internally reorganized into three combat commands: CCA, CCB, and CCR (Reserve). As an example of typical divisional engineer support, from 4 to 8 August 1944, the 17th Armored Engineers, 2d Armored Division had Companies A and B with CCA and CCB respectively, Company D attached to the 82nd Reconnaissance

Battalion, and Company C under division control (U.S. Armor School 1950, 110). However, "the division engineer battalions did not have the strength and equipment to meet all requirements of the division. . . " (Engineer Operations VII Corps 1949, 5).

World War II engineers faced extensive enemy mine threats. Enemy "mine [warfare] caused considerable problems. . . the war ended with the engineers still relying on the one method of mine sweeping used from the start: a sharp-eyed veteran probing with a bayonet. . . " (Beck et al. 1985, 564). This same technique continues in use today. The only significant change is the use of a fiberglass rod instead of a bayonet.

The Germans extensively mined and booby-trapped during World War II. In Italy, the Germans constructed a series of thick defensive belts along the length of the Italian Peninsula. As the Allied forces attacked north, they ran into increasingly dense minefields, road craters, and elaborate German defenses. World War II mine clearing was a slow, meticulous process requiring many men and involving great risks. For example, the 10th Engineer Battalion, 3rd Infantry Division "suffered fifty-seven casualties. . . in clearing 20,000 mines. . . during a period of sixteen days"

(Beck 1985, 181). Similarly, the 16th Engineers cleared mines from over 900 miles of road for the 1st Armored Division. Unfortunately, none of the many mine-clearing expedients tested during World War II proved effective. The five methods of breaching during WWII were; hand emplaced charges, hand removal, artillery fire and aerial bombardment, bridging, and direct fire from tanks or tank destroyers. Consequently, armored and infantry division attacks frequently moved at the speed of their dismounted engineer mine clearing teams (U.S. Armor School 1950, 54).

Similarly, rivers, destroyed roads or bridges, and or enemy obstacles regularly stopped attacks. Engineer battalions, at all echelons, built bridges to cross-streams, rivers, road craters, and destroyed culverts. In Italy, for example, engineers constructed over 3,000 Bailey Bridges in a twenty-month period. The speed of bridge construction frequently determined the tempo of allied operations (Brinkley 1998, 25).

During the Italian campaign, engineers developed a standard operating procedure to maximize engineer work and force mobility. Divisional engineers expediently crossed streams. Corps engineers followed, replacing expedient fills and bypasses with culverts and Bailey Bridges.

Finally, Army engineers replaced temporary crossing expedients with permanent fixed bridging (Beck 169).

France and Germany offered similar gap crossing challenges. Multiple streams, rivers, and gaps traverse both countries requiring many military crossings. The Corps' tanks required that over 80 percent be heavy Class forty bridges, since the Germans destroyed most bridges and culverts during their withdrawal. The XIX Corps engineers built 262 bridges during this same time period. These were only two corps' requirements for bridging. Except for North Africa, all subtheaters in the ETO required frequent major river crossing operations (Brinkley 1998, 26).

The Ninth Army planned extensively for the Rhine River crossing and considered detailed river characteristics, photo intelligence, and flood prognostication in deciding on the river crossing area and the required engineer effort. Ninth Army planned to cross with two corps, with two each assaulting battalions. The Ninth Army engineer's plan called for constructing two Class 40 bridges and one Class 25 bridge in each division sector. The construction of one semipermanent, two-way Class 40 bridge and one one-way Class 70-pile bridge would commence after the construction of assault bridges (Brinkley 1998, 26).

One corps with five battalions actually assaulted across the Rhine. Simultaneously, engineers were constructing seven Class 40 float bridges, two 25-ton pontoon bridges in support of the assault and follow-on fixed bridging as planned. Between 26 March and 23 April 1945, the Ninth Army engineers crossed approximately two and a half million vehicles over the Rhine. By the third day of the assault, over 185,000 vehicles a day crossed these bridges (Brinkley 1998, 26).

The Rhine River crossing was the largest river crossing undertaken by U.S. engineers during World War II. In preparation to cross the Rhine, the assaulting divisions and their supporting engineers left the line and conducted river crossing training and rehearsal. The 1153rd and the 1148th Engineer Combat Groups joined the 30th and 79th Infantry Divisions, respectively, to train for the assault crossing (Ninth Army River Crossing 1945, 7). Two key points should be noted: a brigade-sized engineer element was task organized to a division; and second, the divisions and their engineer groups were pulled from the line in order to train and rehearse the crossing together. Both points are key because they provided instant and accurate information with command emphasis to the command group.

Also critical to the operation was the current disposition of the terrain. Even narrow, dry gaps impeded movement. It took a trained squad eleven minutes to emplace a 36-foot span and only if the bridging was already on site, in order to allow tanks to continue their advance. "Bridging, from a major tactical standpoint, completely predominated all other armored engineer missions during the Central Europe exploitation campaign" (U.S. Armor School 1950, 190).

Engineers additionally constructed the infrastructure needed for sustainment purposes. However, high-intensity combat in Europe did not require the extensive base camp facilities required for Bosnia or Vietnam; Army level engineers conducted construction and facilities renovation, especially ports. Division and corps level combat engineers primarily constructed and maintained main supply routes, roads, and nonstandard timber bridges. Major General C. R. Moore, Chief of Engineers, European Theater of Operations, recommended the allocation of three engineer construction battalions to support each three division corps or one per committed division (Final Report Chief Engineers ETO 1946, 135). A Fort Knox study of ETO armored engineers confirmed that the task of road repair and construction was completed by division and corps level engineers and never ended (Brinkley 1998, 27).

The most significant engineer issue during World War II was the command and control of large numbers of engineers supporting each division. Army Force XXI will face the same command and control challenges with the absence of the divisional engineer brigade headquarters in the Army Force XXI force structure. Three corps engineer organizations alleviated inadequate divisional engineer structure. A corps combat engineer regiment (engineer brigade or group) directly reinforced each division with combat engineers. A general service engineer regiment built combat support bridging, maintained roads and railroads, and provided general engineer support for corps sustainment operations. Finally, a corps pontoon bridge company maintained a pool of bridging equipment and boats for assault crossings.

Examination of Adequacy

An engineer battalion adequately supported each brigade, and each committed division requires at least two engineer battalions and two bridge companies to enjoy a modicum of mobility. In World War II, a corps engineer regiment was in support. Each attacking regiment normally received an engineer battalion in support. Engineer companies were also frequently supporting infantry and armor battalions. As the war progressed, engineers became the largest single divisional slice component (Brinkley 1998, 28).

The divisional engineer battalion could not adequately provide this level of support. This created a command and control dilemma for Major General Moore, whom noted that "the staff prescribed by the present T/O was an inadequate division" (Final Report Chief Engineers ETO 1946, 139). He recommended fielding a corps engineer brigade commanded by a brigadier general. During World War II, the Corps Engineer was a staff officer without formal command authority. Though he informally led and controlled all engineers in sector, he was neither organized nor formally given command and control over subordinate elements to perform the task adequately. The redesign and acceptance of the corps engineer brigade rectified this shortcoming (Brinkley 1998, 28).

Similar command and control problems were observed when engineer groups directly supported divisions. Higher-ranking officers with staffs more robust than the division engineer staffs frequently commanded the supporting engineer organizations. The command and control structure of the division engineer became severely strained and just could not adequately integrate supporting army and corps-level engineers. As a result, General Moore recommended that divisions needed an engineer regimental structure in order to exercise adequate divisional engineer command and control (Brinkley 1998, 29).

The organic divisional engineer structure inadequately provided this level of command and control, frequently necessitating corps-level headquarters augmentation. This ad hoc command and control (C2) organization proved adequate, not necessarily desirable. Finally, General Moore suggested that the regimental organization appeared to have supported the division better than the divisional battalion and corps engineer group combination. The current divisional engineer brigade structure is very partial towards General Moore's recommendation. In the World War II and the current divisional engineer brigade, three organic battalions are assigned with habitual support to the brigade combat team.

In summary, American Army experiences in World War II illuminated several key points relative to the employment of engineers on the battlefield:

1. Engineer units faced severely restricted terrain, extensive hydrology, war-torn infrastructure, and serious mine threats that could not be accomplished by the organic engineer units assigned to the division. Additional engineer assets from Corps engineer units were required to adequately support the division mission.

2. The division engineer battalions did not have the organic strength and equipment to meet all the requirements of the division, therefore required support from EAD engineer units to augment the force.

3. Armored and infantry division attacks frequently moved at the speed of their dismounted engineer mine clearing teams due to the dense enemy defenses constructed in depth. Lack of sufficient breaching techniques and successful bypass identification, contributed to the dismount with a bayonet probing leading the attack.

4. As a result of river and gap crossings, the speed of bridge construction determined the tempo of allied operations.

5. Engineers built the infrastructure required for sustainment purposes (not extensive as Vietnam and Bosnia).

6. The command and control of large numbers of engineers supporting each division became a significant

force structure challenge that required an innovative, robust engineer headquarters. A robust engineer headquarters was organized in an ad hoc manner. Although this ad hoc organization proved adequate, but was not necessarily desirable.

7. Significant numbers of Engineers were required to conduct other battlefield missions in theater, including countermobility tasks. The other battlefield missions were normally conducted by corps level engineer augmentation.

Case Study #2--Operation Desert Storm

Operation Desert Storm is the U.S. Army's latest experience in large-scale armored warfare involving three U.S. armored divisions, two mechanized infantry divisions, and two-armored cavalry regiments fought in the Gulf War. The engineer support provided to the U.S. Army consisted of two corps engineer brigades and three "provisional" divisional engineer brigades (regiments). The Gulf War saw the reintroduction of a division-level; brigades sized, and engineer headquarters (Brinkley 1998, 29).

Engineer Support Operations

River crossings, bridging, and base camp construction were not priority missions for the deploying engineers because of the areas open topography and preestablished facilities. Saudi Arabia, Iraq, and Kuwait offered few of the natural water obstacles associated with operations in Vietnam, Bosnia, or World War II Europe. The Euphrates River was the only significant river in the entire theater that would have required river crossing and bridging operations. As a result of over forty years of construction, the Saudi Arabian infrastructure more than adequately supported deploying U.S. and allied units. Bridging units downloaded their bridges and augmented the logistical transportation system with their movers (trucks less their boats) because of the limited bridging requirement (Brinkley 1998, 29).

Similarly, many Armored Vehicle Launched Bridges (AVLB) downloaded their bridges in order to mount two Mine Clearing Line Charge (MICLIC). The AVLB less its bridge was renamed as the Armored Vehicle Launched MICLIC (AVLM). The AVLMs with MICLICs were great field expedients in overcoming the MICLIC trailer's limited cross-country mobility, trafficability and sustainability. The 1st and 2nd Marine Divisions used MICLICs to breach minefields lanes into Kuwait. Although, the Army did not extensively use MICLICs during the war, the 1st and 2nd Marine

Divisions used MICLICs to breach minefield lanes into Kuwait (Brinkley 1998, 30).

Ten combat heavy battalions built and maintained roads and trails throughout the theater significantly augmenting the existing road system. These additional roads enable the enormous logistical effort required by the heavily armored force to move forward unimpeded as a result of poor road networks. Both VII and XVIII Corps attacked through the roughest and most underdeveloped parts of Iraq where the existing road systems were practically nonexistent. Engineer construction units built and maintained the main supply routes (MSRs) for both corps' sustainment efforts (Brinkley 1998, 30).

As in the European Theater during World War II, mines posed a significant threat in the Southwest Asia Theater. The Iraqi border defenses posed the most significant engineer problem of Desert Storm with fire trenches, extensive minefields and tank ditches, and others. Norman Friedman, in *Certain Victory*, considered the Iraqi engineers highly experienced and motivated. Their contributions toward Desert Storm consisted of a complex network of defensive positions; minefields, fire trenches, and antitank obstacles representing one of the most densely mined defenses since World War II (Friedman, Norman 1991, 13).

The U.S. Army fielded provisional engineer headquarters to command and control additional engineer battalions required for breaching the complex obstacles constructed by the Iraqis. The 1st Infantry Division deployed to Southwest Asia (SWA) with its organic divisional engineer battalion and as part of the U.S. VII Corps. As VII Corps' primary breach force, the 1st Infantry Division was task organized with three corps combat engineer battalions commanded by a provisional engineer brigade. This concept was known at the time as E-Force, for Engineer Force (Brinkley 1998, 31).

The VII Corps used the E-Force concept with all of its divisions in Southwest Asia. E-Force placed a division level engineer brigade (regiment) structure with an engineer battalion in direct support of a maneuver brigade. E-Force and the provisional engineer brigades saw service in the Gulf War with the 1st Infantry, 1st Armored, and 3rd Armored Divisions (Brinkley 31).

Additionally, combat engineers were tasked to be able to execute a variety of tasks:

1. Emplace tactical and protective obstacles for friendly forces

2. Constructing protective berms

3. Logistical bases

4. Fuel points

5. Mobile ambulatory surgical hospital (MASH) sites

6. Main supply route (MSR) construction

7. Demilitarize enemy equipment (vehicles and weapons)

Examination of Adequacy

The Desert Storm provisional engineer brigade (E-Force) negated the need for an ad hoc command and control organization. The provisional engineer brigade provided a flexible and adaptable engineer command and control component that controlled additional engineer units that was not organic to the division. The wartime S3 of the 16th Engineer Battalion offered that the new engineer brigade concept, ". . . really works. No other reasonable force structure could place sufficient combat engineers, properly armed and equipped, on the battlefield to support heavy mechanized or armored divisions" (Kirch 1991, 25).

The provisional engineer brigade proved to be a significant innovation (a repeat of World War II) and was key to the 1st Infantry Division's successful breach. Additionally, two new specialized engineer pieces of equipment, the armored combat earthmover (ACE) and the tank mounted plow, made the task of breaching quicker and more efficient. The ACE and track-width, tank-mounted, mine plow collapsed Iraqi berms and trenches and cleared lanes through minefields. These new systems were fielded just prior to Operation Desert Storm and are still a part of the U.S. Army inventory.

The M9 ACE furnished an armored earthmover capable of advancing with tanks and a higher speed associated with the D-Series bulldozers. Leading the breaching effort, 1st Infantry Division ACEs cut twenty lanes through the Iraqi border antitank berm (Tice 1991, 20). The ACE proved to be instrumental in trench clearing by burying enemy soldiers who elected to continue to fight from the trenches. The ACE mitigated the division from a costly, dismounted trench battle and preserved the 1st Infantry Division's tempo. The 1st Armored Division's senior leaders were amazed with the ACEs versatility (Brinkley 1998, 32). The M9 ACE with its current modernization and rebuild program will still be relevant for the future.

The track width mine plow enabled maneuver forces to rapidly breach on the move, which maintained the momentum of the attack of the supported unit. The sandy soil and relatively flat terrain offered ideal ground for tank plows. The 1st Brigade 2nd Armored Division used their mine plows to widen lanes breached by the 2nd Marine Division MICLICs in the eastern area of operations. The "Conduct of the Persian Gulf War," The Final Report to Congress states that, "the [mine plow]. . . was an effective tool, creating easily visible lanes for follow-on forces" (Scicchitano 1991, 18).

Most importantly, Operation Desert Storm introduced a major change to the divisional-level engineer organization. A study done just prior the war "concluded that combat engineer support in divisions ought to be increased by over 200 percent" (Brinkerhoff 1997, 18). The 1st Infantry Division's wartime endstate allocation of five engineer battalions (four combats, one construction) demonstrated the validity of this study. The provisional engineer brigade demonstrated the ability to command and control a force of this size across the depth and breadth of the battlefield (Coleman et al. 1997).

High Intensity Operations Conclusions

War against similar armed and equipped foes represents the most hazardous scenario the U.S. Army faces on the future digitized battlefield. The previous two case studies emphasize several key capabilities that armored engineers need on the high intensity battlefield. In World War II, fledging armored divisions attacked in mass across Europe in pursuit of the German Army. However these divisions frequently had to stop before enemy minefields, destroyed roads, blown bridge, and natural terrain obstacles and allow their engineer support to move forward and perform the necessary support to continue the attack.

The divisional engineer structure in World War II did not adequately support fast-paced armored operations primarily due to equipment capabilities on-hand. The ingredient required for the division was both speed and agility. Therefore, engineer groups were formed to command and control the two to three battalion normally augmenting the divisions. The divisional battalion and engineer group configuration proved adequate but not optimal primarily due to not training together as an organic or habitual unit. Several command and control concerns arose from this configuration. The removal of divisional engineer regiments (prior to the war) left divisions with inadequate engineer support as well as the inability to command and control multiple engineer battalions for multiple missions such as construction, river crossings, bridging and breaching. Engineer groups were fielded in an attempt to fill the void and quickly gain control of the additional engineer unit within the division.

As mentioned in an earlier example, the 30th and the 79th infantry Divisions were each allocated an engineer group that was not organic to the division for crossing the Rhine. In World War II, General Moore, the theater engineer, concluded that a brigade-size engineer organization clearly provided adequate support to an armored division. The engineer regiments could better support the divisions and were preferable to the battalion and group combination. General Moore additionally recommended a division allocation of four combat engineer battalions and one construction battalion. Unlike World War II, Army Force XXI will operate without an Engineer Brigade Headquarters. As seen in World War II, if Army Force XXI is required to command and control additional engineer units, a provisional engineer brigade will be required to manage the additional engineer assets.

Bridging was one the most important hallmarks of the engineers in World War II. The other important hallmarks were their breaching and construction support. The war saw the development of the Bailey Bridge and other dependable bridging systems. These spans were necessary for rapidly moving armored forces, particularly in Italy. The fast moving armored divisions' logistical traffic also depended on engineer emplaced bridging and road networks. Thousands of bridges were built in Europe. Although the force had no rapidly emplacing bridging. No AVLB equivalent existed allowing rapid crossing of small gaps and streams. A recommendation for a tank-based bridge was made toward the end of war, and was not fielded until the early 1960s (Brinkley 1998, 34).

Operation Desert Storm saw improvements in all of the areas or shortfalls previously discussed. The engineers received the MICLIC and full-width mine rakes for the Combat Engineer Vehicle (CEV). Fielded in Vietnam, the CEV "mounting the. . . [full width mine rake] provided the only full-width breaching capability for the U.S. Army" (U.S. DOD Conduct of Gulf War 1992, 135). Both proved to be effective during the Gulf War. Army Force XXI will still have a requirement for these same systems that were improved upon during World War II, Desert Storm, and the current force structure.

Additionally, the Gulf War reintroduced the necessity for the provisional engineer regiments. Now called engineer brigades, provided first-class command and control responsibility for all subordinate engineer units. It marked the first organic, functional brigade sized, engineer organization in a division since 1935. The division engineers in both World War II and Vietnam, particularly operating under an ad hoc temporary headquarters, proved to be inadequate. An U.S. Army Engineer School complex breach computer simulation demonstrated, as well, that the divisional engineer brigade "gives the division more command and control over its organic engineers and other allocated engineers from corps" (USAES Technical Report 1950, 43).

In conclusion, historical examples illustrate the need for a very robust engineer force structure capable of responding to multiple battlefield requirements, including extensive mobility, countermobility and survivability tasks. Tasks included in World War II were: Traversing severely restricted terrain, extensive hydrology, war-torn infrastructure, and serious mine threats; organizing and executing mine clearing operations with mine clearing teams; bridge construction; and infrastructure construction.

Tasks included during Operation Desert Storm were emplacing tactical and protective obstacles; constructing berms, logistical bases, fuel points, and MASH sites; main supply route (MSR) construction and maintenance; and demilitarize enemy military equipment.

Today, we face similar challenges as we transition from the Army of Excellence to the Army Force XXI design. As these historical examples reveal, we must not assume that requirements for engineers will be limited strictly to mobility operations. Instead, engineers must be adaptable, flexible, and powerful enough in design to respond to whatever the situation calls for, to include likely countermobility tasks.

Army Force XXI Engineer Utilization Survey

To further research the validity of my basic hypothesis, I conducted a sample survey of forty-eight engineer officers assigned to the U.S. Army Command and General Staff College. The survey instrument consisted of eight questions using a Lickert scale to rank the responses.

The purpose of the survey is to gather qualitative information from combat engineers for the study. The questionnaire consists of five questions regarding the relevance of countermobilty in the Army Force XXI, two questions pertaining to service in a digitized division or brigade, and one question to identify familiarity of TRADOC PAM 525-5 (Force XXI Operations 1994).

Table 1 shows the accumulative raw data collected from the sample population in regards to countermobilty requirements for Army Force XXI. The Lickert scale consisted of five responses: strongly agreed, slightly agreed, neutral, slightly disagreed, and strongly disagreed. A favorable column was added to identify the net favorable responses. A favorable response was based on a sixty-six percent cut line.

1. Overall seventy-five percent strongly agreed and twenty-five percent slightly agreed that it is essential for current maneuver forces to retain a robust countermobility capability.

2. Overall seventy-nine percent strongly agreed and twenty-one percent slightly agreed that for the foreseeable future (digitized battlefield), it is essential for

maneuver forces to retain a robust countermobility capability.

3. Overall fifteen percent strongly agreed and seventeen percent slightly agreed that the U.S. Army focuses adequate research on countermobility in Force XXI operations as needed.

4. Overall zero percent strongly agreed and ten percent slightly agreed that the U.S. Army focuses adequately on countermobility in Force XXI operations as needed.

5. Overall fifty-four percent strongly agreed and twenty-seven percent slightly agreed that due to the increased dispersion of units across the battlefield of the future, Force XXI digitized units will require more of a countermobility capability than current units.

Table 2 shows the accumulative raw data collected from the sample population in regards to their familiarization with TRADOC PAM 525-5 (Force XXI Operations). The Lickert scale consisted of five responses: very familiar, slightly familiar, neutral, slightly unfamiliar, and very unfamiliar. A favorable column was added to identify the net favorable responses. A favorable response was based on a sixty-six percent cut line.

Overall twenty-one percent was very familiar and thirty-five percent slightly familiar with TRADOC PAM 525-5 (Force XXI Operations).

Table 1. Army Force XXI Requirements

Questions	**Strongly Agree %**	**Slightly Agree %**	**Favorable %**	**Neutral %**	**Slightly Disagree %**	**Strongly Disagree %**
1. It is essential for current maneuver forces to retain a robust countermobility capability?	75	25	100	0	0	0
2. For the foreseeable future (digitized battlefield), it is essential for maneuver forces to retain a robust countermobility capability?	79	21	100	0	0	0
3. The U.S. Army focuses adequate research on countermobility in Force XXI?	15	17	32	15	35	19
Questions-Continued	**Strongly Agree %**	**Slightly Agree %**	**Favorable %**	**Neutral %**	**Slightly Disagree %**	**Strongly Disagree %**
4. The U.S. Army focuses adequately on countermobility in Force XXI operations as needed?	0	10	10	30	35	25
5. Due to the increased dispersion of units across the battlefield of the future, Force XXI digitized units will require more of a countermobility capability than current units?	54	27	81	11	8	0

Table 2. DA PAM 525-5 Familiarization

Question	**Very Familiar %**	**Slightly Familiar %**	**Favorable %**	**Neutral %**	**Slightly Unfamiliar %**	**Very Unfamiliar %**
1. How familiar are you with TRADOC PAM 525-5 (Force XXI Operations)?	21	35	56	21	15	7

Table 3 shows the accumulative raw data collected from the sample population in regards to have served in both an Army Forces XXI digitized brigade and maneuver brigade combat team.

1. Overall six percent served and ninety-four percent did not serve in an Army Force XXI digitized division/brigade.

2. Overall seventy-three percent served and twenty-seven percent did not serve in a maneuver brigade combat team.

Table 3. Brigade Combat Team Experience

Question	Yes %	No %
1. Have you served in an Army Force XXI digitized division/brigade?	6	94
2. Have you served in a Maneuver Brigade Combat Team?	73	27

In conclusion the Army Force XXI Engineer Utilization Survey concluded the following amongst the forty-eight engineer officers assigned to the U.S. Army Command and General Staff College:

1. It is essential for current maneuver forces to retain a robust countermobility capability.

2. For the foreseeable future (digitized battlefield), it is essential for maneuver forces to retain a robust countermobility capability.

3. The U.S. Army does not focus adequate research on countermobility in Force XXI operations as needed.

4. The U.S. Army does not focus adequately on countermobility in Force XXI operations as needed.

5. Due to the increased dispersion of units across the battlefield of the future, Force XXI digitized units will require more of a countermobility capability than current units.

6. A very small percentage (six percent) of combat engineers have served in an Army Force XXI digitized division/brigade.

7. A large percentage (seventy-three percent) of combat engineers has served in a Maneuver Brigade Combat Team.

In conclusion, the survey proved to be a valuable tool to assess the current thought process and general maneuver experience of the combat engineers of the Command and General Staff Officer College class of 2000.

CHAPTER 4

ANALYSIS

Introduction

> Future land units will exploit terrain by maneuvering for tactical advantage within the fields and undulations of the earth's surface without suffering the restrictions imposed on mobility by contact with the ground (Knowledge and Speed 1997, 18).

It is first important to take a brief look at the origin of countermobilty doctrine and equipment of the current Army of Excellence and the future Army Force XXI. Throughout this chapter, this thesis will provide a comparative analysis between the Army of Excellence and Army Force XXI. Two areas were selected to be compared that would provide a good basis for a comparative analysis. The first will be doctrine, the diary that has captured our lessons learned from the past and intuitive attempts to describe the future. The second element to be compared will be the equipment and capabilities for Army of Excellence and Army Force XXI. This area will be described through doctrinal definitions.

Army of Excellence Doctrine

The Army of Excellence countermobility doctrine and equipment were focused upon a modern battlefield against an enemy using Soviet style tactics and organizations.

Army of Excellence countermobility outlines in detail our importance of understanding how the enemy (highly trained enemy forces using Soviet doctrine) will fight on the modern day battlefield of this particular time period. Also, the threat offensive combat is predicted upon mobility, high rates of advance, surprise, and secrecy.

Second, Army of Excellence doctrine discusses types of obstacles and the principles of obstacle employment. The types of obstacles discussed are existing and reinforcing obstacles. Existing obstacles are already present on the battlefield and not placed there through and with military effort. Reinforcing obstacles are placed on the battlefield through and with military effort and are designed to strength the existing terrain to slow, stop, or canalize the enemy.

The principles of obstacle employment include carefully matching obstacles to the terrain. Terrain reinforcement techniques must be employed along the depth of the enemy formation and avenue of approach. Reinforcing obstacles are the primary means for achieving the principle methods of terrain reinforcement. Reinforcing obstacles must: support the maneuver commanders plan; integrate with observed fires; integrate with existing obstacles and other reinforcing obstacles; be employed in depth and surprise.

Third, Army of Excellence doctrine discusses command and control, obstacle planning, and mine warfare. Command and control outlines the importance and absolute mandate must for countermobility operations levels of responsibility. In particular, it highlights the execution of the reserve obstacles (a reserve obstacle is an obstacle or demolition target the commander deems critical to the tactical plan).

Planning considerations discussed for the offensive, defensive and retrograde missions are: analyze the mission; directed and reserve obstacles; future plans; enemy strengths and weaknesses; terrain and weather; available resources and effects on local population. Retrograde operations are planned by corps and divisions, but may be carried out by brigade. Reserve and retrograde operations are centralized planned, but decentralized executed.

Mine Warfare, in accordance with Army of Excellence doctrine, lists five minefields as being: protective, tactical, point, interdiction, and phony (FM 20-32 1992, 2-1).

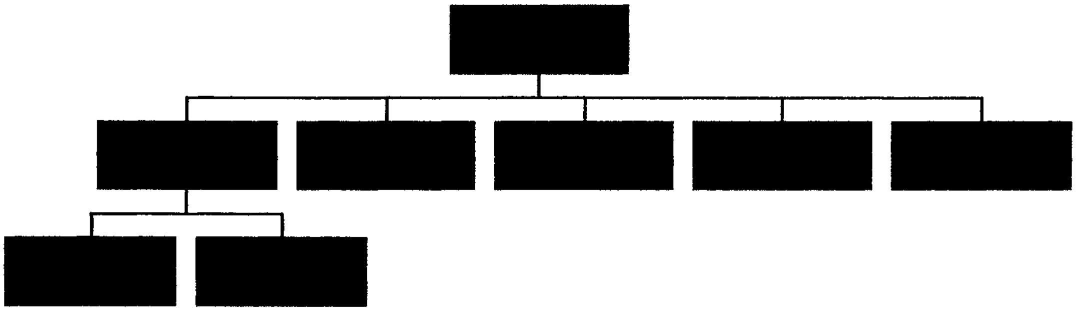

Figure 1. Minefield Description

Protective obstacles are both hasty and deliberate, aiding units in local and close-in protection. Tactical minefields channelize, delay and disrupt enemy attacks; reduce enemy mobility; block enemy penetrations; increase effectiveness of friendly fire; delay enemy withdrawal; prevent enemy reinforcement; protect friendly flanks; destroy or disable enemy vehicles and personnel. Point minefields are of irregular size and shape to disorganize enemy forces and hinder their use of key areas. Interdiction minefields are placed on the enemy or in his rear areas to kill, disorganize, disrupt line of communication and command control facilities. Phony minefields simulate live minefields and deceive the enemy.

Fourth, Army of Excellence doctrine briefly discusses obstacles other than minefields and denial operations. Obstacles other than minefields are: bridge demolitions, non-nuclear craters, antitank ditches, expedient obstacles, preconstructed obstacles, and atomic demolition munitions. Bridging demolitions are the act of demolishing or rendering an existing bridge unserviceable, forcing the enemy to conduct a river crossing. A non-nuclear crater's purpose is to delay or stop the enemy, forcing him to prematurely utilize breaching and earth moving equipment. Antitank ditches are designed to degrade an attacking force's speed and mobility. Expedient obstacles are: abatis, log obstacles, rubble, junked automobiles and battle damaged equipment, flooding, and fires. Preconstructed obstacles are constructed and prepared during peacetime for rapid execution during hostilities. Atomic demolition munitions are nuclear demolition devices used for obstacle creation or denial operations and can only be executed after authority to employ nuclear weapons has been granted (Sloan 42).

Collectively, Army of Excellence doctrine regards countermobility as one of the key tasks required of engineers on the battlefield and dedicates extensive consideration to detailing the ways and means of employing countermobility.

Finally, Army of Excellence doctrine suggests considerations for special operations: supporting light forces; special terrain environments; combined operations; and contingency operations.

As a result of World War II, Korea, Vietnam, and Desert Storm, Army of Excellence proved to be a vital part in determining how the U.S. Army will fight its wars. As the U.S. Army transitions with time and space, a more lethal and more agile force would be designed to support the pre-information an information age era. To satisfy this change, the U.S. Army concluded that a change from a forward-deployed organization to a force projection force would be required. Thus, the concept of Army Force XXI was initiated.

Army Force XXI Doctrine

Since 1993, the Training and Doctrine Command (TRADOC) has been in the process of restructuring for tomorrow's digitized Army. Through numerous seminars, analysis, and Advanced Warfighter Experiments, a new heavy digitized Division was designed. In June 1998, Army Chief of Staff, General Reimer, approved the Army Force XXI division design (Flowers, Lowrey, and Porter 1998, 1).

Currently, no changes have been made to FM 5-102, Countermobility Operations, dated 1985, since its original distribution. The same practices and definitions still apply and are being applied today. Therefore, the doctrinal changes to be discussed will focus on the modification of the force structure and the equipment that will support it (Krueger 1998, 4).

Army Force XXI division, brigade, and battalion engineers will be required to change the way they do business currently in the Army of Excellence force structure as it transitions to Army Force XXI. The Army Force XXI division has three major changes in engineer structure compared to the current Army of Excellence division:

1. An engineer staff element is part of the division headquarters and headquarters company (HHC) versus the current separate division engineer brigade headquarters. An engineer staff will be embedded in the division command post, will replace the engineer brigade headquarters. Because of the engineer staff section, this change can

potentially be hazardous when augmented with additional engineer units.

2. An engineer battalion is assigned to each brigade combat team (BCT) in the division--rather than being assigned to the division engineer brigade headquarters as it is today. This concept will allow the brigade combat team to have more direct command and control of its slice elements.

3. All combat service support (CSS)(less medical) for the engineer battalion is provided by the base support company (BSC) of the BCT forward support battalion--versus the current engineer battalion with its own CSS (Flowers, Lowrey, and Porter 1998, 3). This change is primarily to support the centralized support concept of supporting forward with a minimal footprint requirement.

In addition to the three major changes in engineer structure, engineer support at echelons above division (EAD) will be incorporated as part of the brigade combat teams plan for countermobility operations. This is critical because most EAD engineer units are in the Reserves or National Guard. This augmentation with the EAD engineer units will be a challenge for engineer staff now embedded in the division command post. Additionally, this may require a provisional engineer brigade headquarters be created to command and control the additional engineer units in order to minimize the disruption to the operational tempo of the division.

Army Force XXI divisional engineer battalions are assigned to the Brigade Combat Team (BCT) commander (See Figure 1):

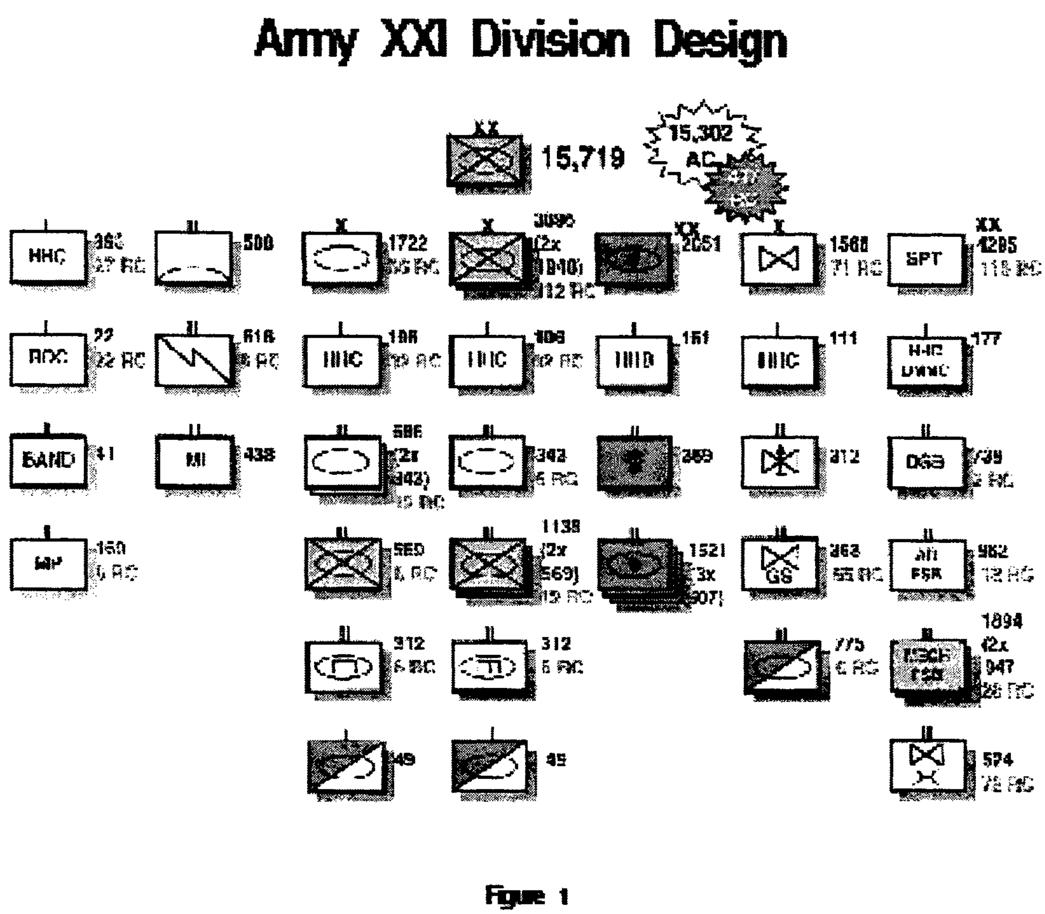

Figure 2. Army Force XXI Heavy Division

This new force structure for the engineer battalion will provide the BCT commander with a responsive mounted obstacle breaching and emplacement, such as Volcano-scatterable (both ground and air) minefields. The Army Force XXI engineer battalion was projected to be fully mounted with Grizzly breachers (formally known as the M1 Breacher), Wolverines heavy assault bridges, and M9 armored combat earth mover (ACE) in support of brigade offensive operations. The countermobility asset, the small emplacement excavation (SEE) will no longer be located with the Army Force XXI engineer battalion. Additionally, the new battalion will have one less engineer (sapper) squad per platoon, limited tactical command posts capability, and fewer ACEs. The change to a more lethal and more agile force, the countermobility threat to the U.S. Army will most likely remain the same. The U.S. Army will depend on its digitized advantage to identify and locate the countermobility threat.

Currently, the Army Force XXI engineer battalion will be augmented by echelons above division to provide increased obstacle reduction and creation capability, deliberate defensive operations, operation in restrictive terrain and other critical engineer missions (Flowers, Lowrey, and Porter 1998, 5).

The absence of one engineer squad per platoon and the requirement to conduct additional coordination with higher echelons will likely result in greater difficulties and challenges associated with coordination now required with units for deliberate defense support. For Army of Excellence engineer countermobility concept and execution, divisional engineer battalions assigned to the organic engineer brigade of the division constructed deliberate defenses.

Additionally, the Engineer School and 4th Infantry Division, Fort Hood, Texas, are evaluating replacing the M113A3 armored personnel carrier (APC) with an M2 Bradley fighting vehicle as an engineer squad vehicle. The M2 Bradley will give increased combat power for an offensive oriented fighting force (Flowers, Lowrey, and Porter 1998, 4). However, while the Engineer Bradley Fighting Vehicle will clearly possess more firepower, the engineer platoon itself will have less countermobility capabilities, and this will require additional coordination with the support platoon leader of the brigade combat team. Upon completion of coordination, manpower is reduced to having a minimal of two soldiers manning the M2 Bradley (driver and tank commander). Hence, coordination will be required with echelons above division engineers for their deliberate defensive capabilities for emplacing reinforcing obstacles.

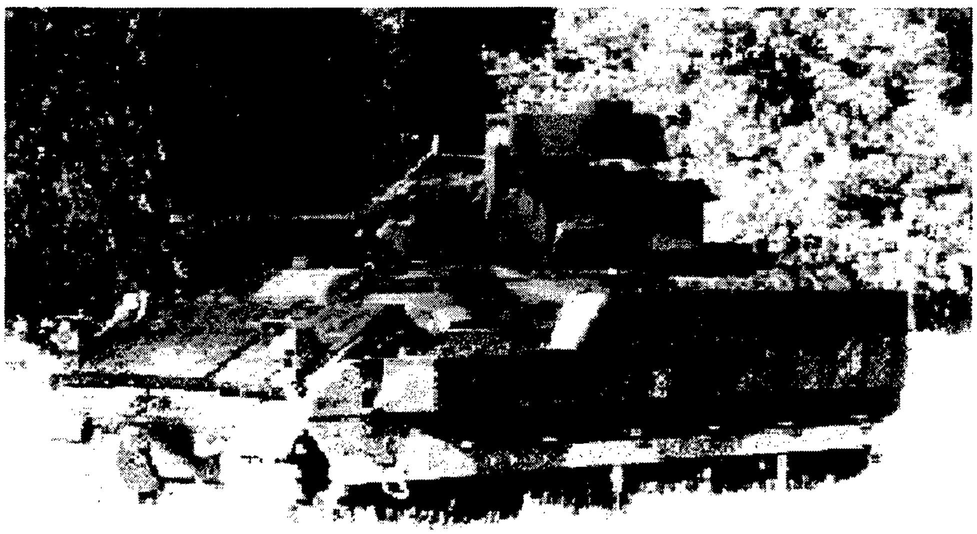

Figure 3. M2 Bradley Engineer Vehicle

Reinforcing obstacles are placed on the battlefield through and with military effort. The primary reinforcing obstacles that will be most likely utilized by Army Force XXI engineers are: VOLCANO (both ground and air), HORNET (formerly known as the family of wide area munitions-*WAM*), area denial artillery munitions/remote antiarmor mine

(ADAM/RAAM), and the modular-pack mine system (MOPMS). Army Force XXI engineers are structured to provide minimal conventional (minefields) obstacle creation.

Additionally, engineer support needed by Army Force XXI engineers must come from echelons above division engineer forces. Careful coordination will be required with echelons above division to emplace the traditional conventional minefields divisional engineers emplaced in the past. The Engineer School is working with TRADOC as part of the Corps XXI redesign process to determine echelon above division engineer doctrine and organizations required to support the Army XXI division. The echelon above division engineer support will come from the Reserve Components of the U.S. Army Reserve and National Guard. This can be a potential problem since some echelon above division engineer units may not be digitized and unable to "plug-in" with Army Force XXI information systems and have the situational awareness that is so critical to the Army Force XXI concept. Anticipated and implied tasks will be to establish extensive liaison capabilities.

While Army Force XXI engineers will likely use self-destruct mines as the primary countermobility asset, it is highly likely that technical expertise in other countermobility obstacles such as road craters, abatis, and log cribs will be required. Physically emplacing these type of obstacles is manpower intensive--an area of obvious shortfall in the Army Force XXI engineer force structure.

Army of Excellence Equipment and Capabilities

The Army of Excellence engineer battalion countermobility equipment and capabilities consisted of twenty-one armored combat earthmovers (M9-ACE), six Volcano's, six combat engineer vehicles (CEV), six small earth excavators (SEE), and ten modular-pack mine system (MOPMS). Additionally, antitank, antipersonnel and limited scatterable mine systems (ADAM/RAAM) were available. The following scatterable mine systems were being tested: GATOR (Gator consists of both antitank and antipersonnel mines delivered by aircraft for close air support, battlefield interdiction, battle-air interdiction and counter-air operations); and Hornet (Hand Emplaced-Hornet engages tracked armored vehicles, and may be armed manually or by the M71 MOPMS Remote Control Unit-*RCU*).

The M9 ACE is capable of performing mobility, countermobility, and survivability tasks in support of heavy or light forces. The ACE can perform excavation and preparation or reduction of obstacles, bridging operations, battle positions, strong points, and protective emplacement for command post, air defense, communications equipment, critical supply or logistical bunkers. Other major tasks will be route clearing and maintenance in conjunction with defensive and offensive operations.

The M9 Ace is currently undergoing improvements to enhance its hull and blade capabilities. Additionally, a micro-climatic cooling system will be fielded for some units (Engineer Systems Handbook 1997, 3).

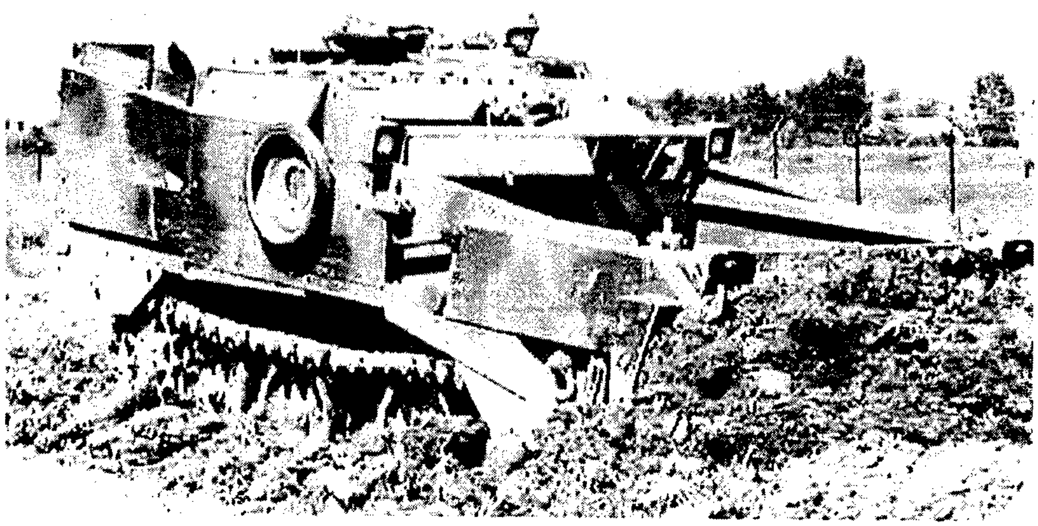

Figure 4. M9 Armored Combat Earthmover

The Volcano (both ground and air) will be employed offensively and defensively to delay enemy movement, isolate the battlefield, and reinforce friendly fires. Volcano will become the standard helicopter mine dispenser system. Additionally, the Volcano will be the principle scatterable mine delivery system for heavy and light forces. The system has the capacity of up to 960 mines and is capable of producing a mined area approximately 1,150 meters by 125 meters. The Volcano responsiveness is limited only by the crew's ability to load the dispenser and the vehicle speed in traveling to and traversing the area to be mined both on the ground and in the air (Engineer Systems Handbook 1997, 60).

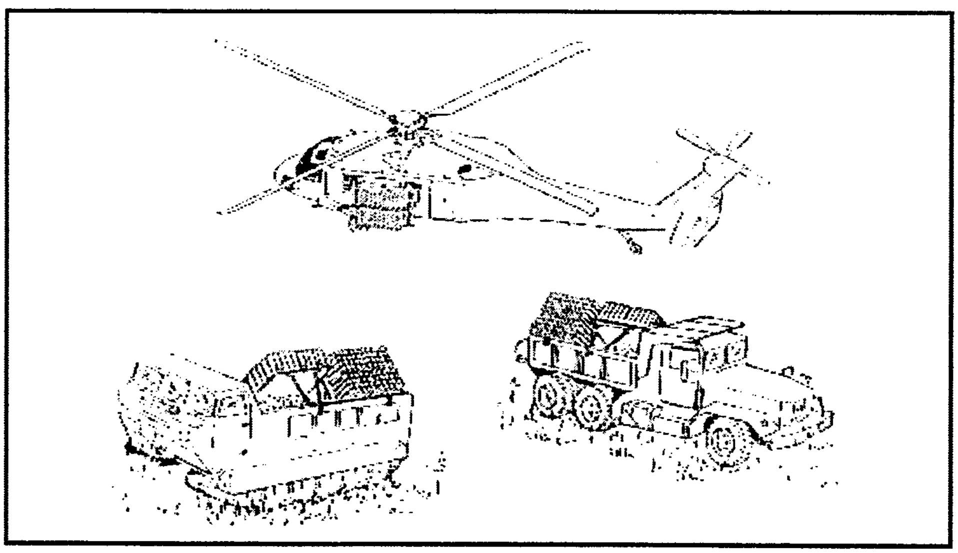

Figure 5. Volcano (Ground and Air)

The Modular Pack Mine System (MOPMS) will be employed to close lanes and gaps in minefields, at choke points, to reinforce obstacles, to emplace point minefields, and for protective mining. Infantry and armor with a protective mining mission will employ MOPMS in support of their tactical missions in all areas of the battlefield. If the mines are not dispensed from its case, the MOPMs can be recovered and reused (Engineer Systems Handbook 1997, 58).

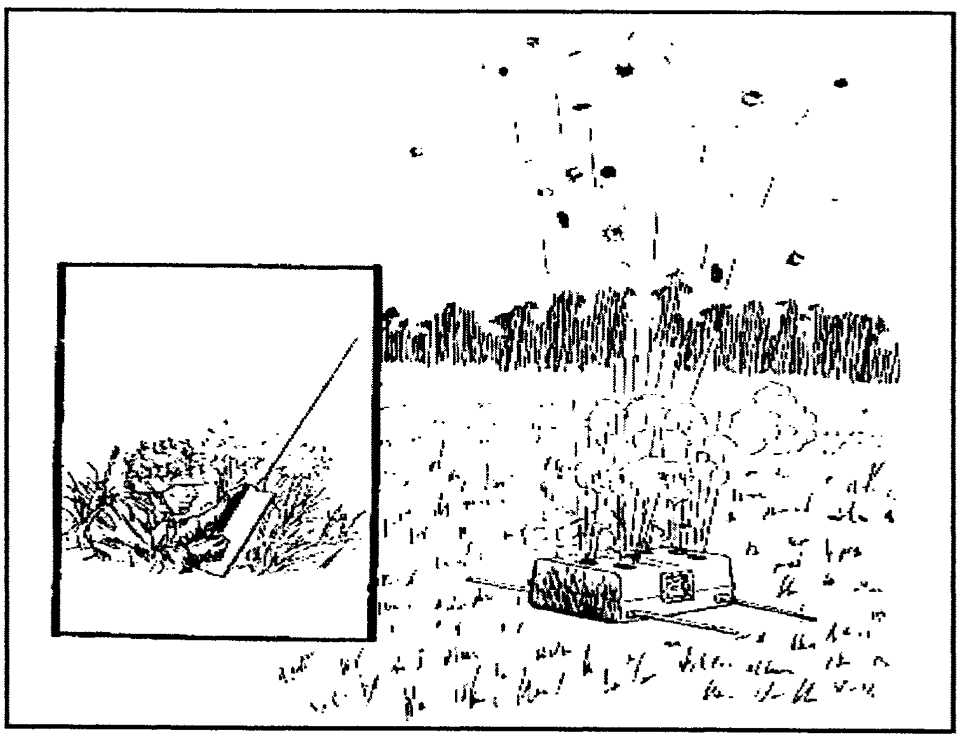

Figure 6. Modular Pack Mine System

The Combat Engineer Vehicle (CEV) will be employed in the forward combat area with versatile, armor-protected means of performing countermobility and mobility tasks. Some tasks include reduction of roadblocks and obstacles; limited construction of combat trails; and construction of obstacles.

The CEV was retired in FY96. It will be retained, as an exception to policy, only with units in or supporting the 2nd Infantry Division in Korea (Engineer Systems Handbook 1997, 41).

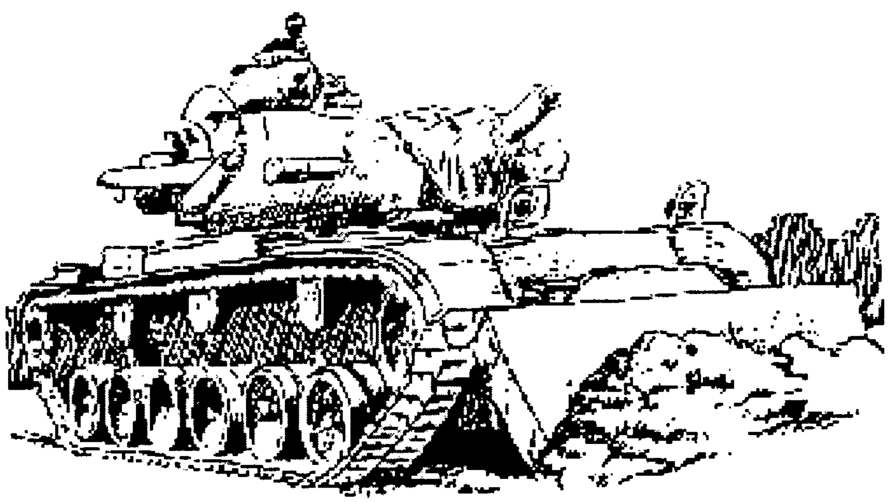

Figure 7. Combat Engineer Vehicle

The Small Earth Excavator (SEE) is the primary piece of equipment utilized by dismounts (primarily infantry). It is also used to rapidly dig combat emplacements (crew served weapons positions, command posts and individual fighting positions) for units in the main battle area. The high mobility of the SEE provides an earthmoving machine capable of rapid movement between battle positions (Engineer Systems Handbook 1997, 65).

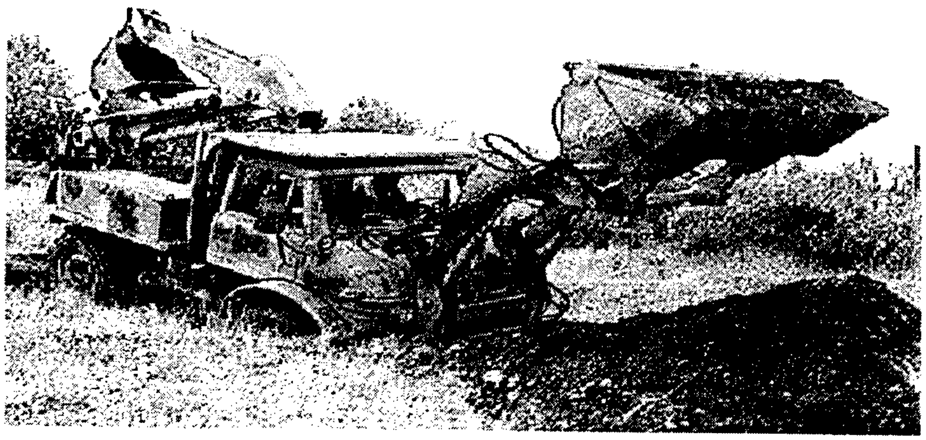

Figure 8. Small Emplacement Excavator

Conventional mines (antitank and anti-personnel mines) can be employed in protective, tactical, point, and interdiction minefields. They can be buried by hand, mechanically, or can be surface emplaced. An accurate record of the number of mines laid and their exact location is maintained. The responsibility for authorizing the emplacement of the mines is vested in the commander whose area is directly affected by the mines (Engineer Systems Handbook 1997, 54).

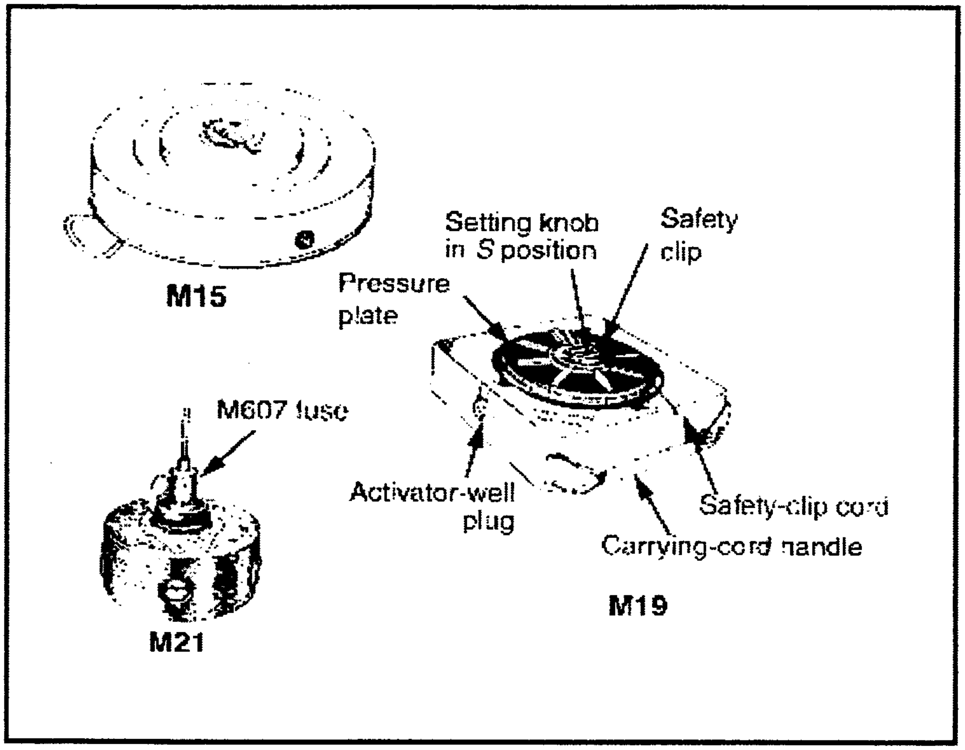

Figure 9. Conventional Antitank Mines

Mine	DODIC	Fuse	Warhead	AHD	Explosive Weight	Mine Weight	Mines per Container
M15 w/M603 fuse	K180	Pressure	Blast	Yes	9.9 kg	13.5 kg	1
M15 w/M624 fuse	K180 (mine) K068 (fuse)	Tilt rod	Blast	Yes	9.9 kg	13.5 kg	1
M19	K250	Pressure	Blast	Yes	9.45 kg	12.6 kg	4
M21	K181	Tilt rod or pressure	SFF	Yes *	4.95 kg	7.6 kg	4

*Conventional AHDs will not couple with this mine; however, the M142 multipurpose FD can be emplaced under this mine.

Figure 10. Antitank Mines Characteristics

In addition to the conventional mine emplacement capabilities of the divisional engineer, a constructed and preconstructed obstacle emplacement capability exists. The constructed and preconstructed obstacles that exist are: wire obstacles, barbed-wire obstacles, triple-stranded concertina, four-strand cattle fence, tanglefoot, knife rest, trestle-apron fence, eleven-row antivehicular wire obstacle, antitank ditches and road craters, log cribs, steel or concrete hedgehogs and tetrahedrons, and heavy equipment tires when available.

Note: Presidential Mandate against the Employment of Anti-Personnel mines dated 16 May 1996 states the following:

1. No employment of anti-personnel mines in training except Korea

2. No individual or collective training except in the context of countermine or demining training

3. No live training on M14 antipersonnel mines

4. Training on M16A1 antipersonnel mines in Korea only.

5. Mine Training Kits and AntiPersonnel mines training are restricted to Korea or Humanitarian demining operations.

6. No policy restricting the use of Self Destruct Anti-Personnel mines.

7. No restriction on M18A1 in command detonation configuration.

8. FY98 DA PAM 350-38, Standards in Weapons Training outlines and clarifies training tasks.

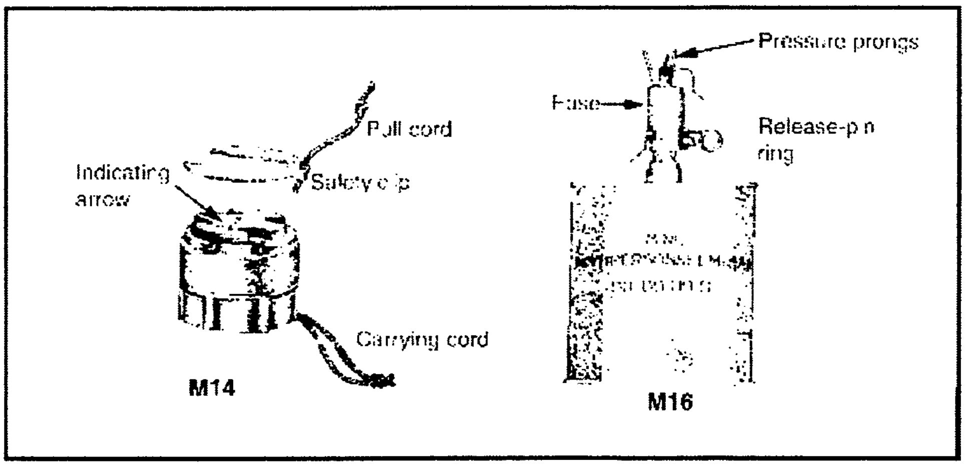

Figure 11. Antipersonnel Mine Characteristics

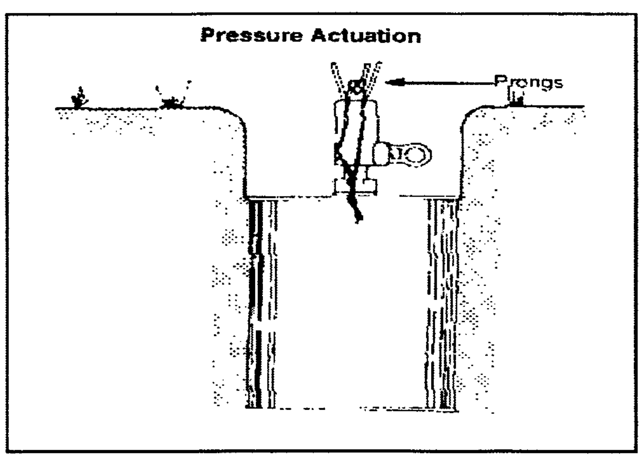

Figure 12. Antipersonnel Mine (Buried)

Mine	DODIC	Fuse	Warhead	AHD	Explosive Weight	Mine Weight	Mines per Container
M14	K121	Pressure	Blast	No	28.4 g	99.4 g	90
M16	K092	Pressure or trip wire	Bounding frag	No	450 g	3.5 kg	4

Figure 13. Antipersonnel Characteristics

Army Force XXI Equipment and Capabilities

The Army Force XXI engineer battalion countermobility equipment and capabilities consists of twelve Grizzly Breachers, six Volcanos, Hornet, area denial artillery munitions/remote antiarmor mine (ADAM/RAAM), and Modular Pack Mine System (MOPMS).

The only difference between Army of Excellence engineers and Army Force XXI engineer capabilities and equipment is the addition of the Grizzly (M1 Breacher) and the Hornet. Additionally the conventional mine, constructed and preconstructed obstacle capability is now performed by echelons above division engineers (See figure 14 below).

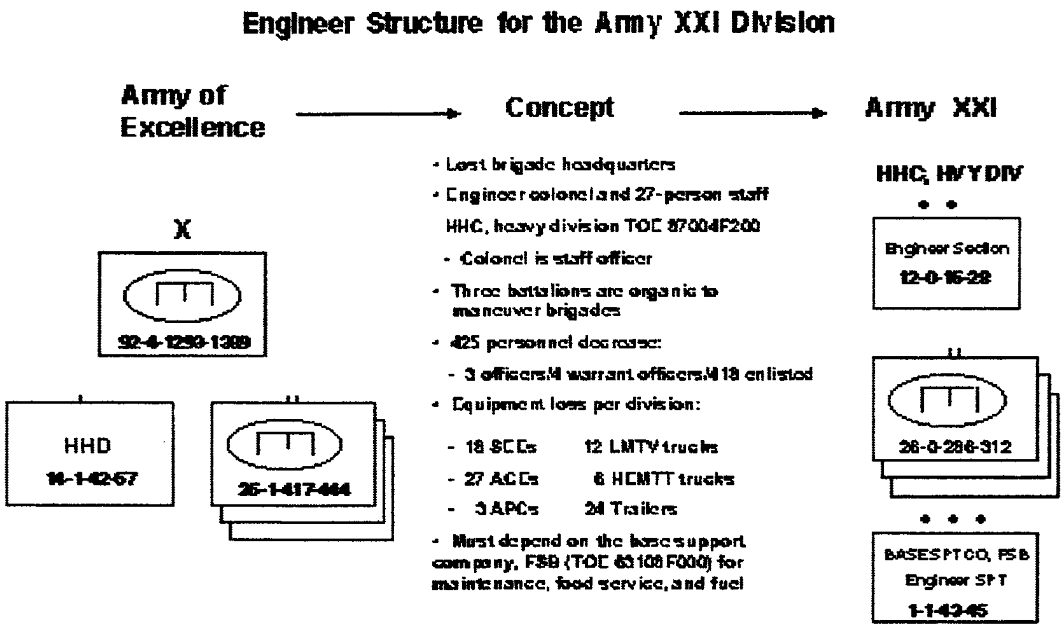

Figure 2

Figure 14. Army of Excellence to Army Force XXI

The Grizzly is a complex obstacle breaching system that integrates advanced countermine and counter-obstacle capabilities into a single survivable system. The Grizzly will accompany the maneuver force and breach lanes in natural obstacles, simple obstacles and complex obstacles. This new system will breach complex obstacles with minimal preparation and with little or no loss in momentum. However, while a great mobility asset, the Grizzly will provide some limited deliberate countermobility capability. One will most likely see the Grizzly constructing deception fighting positions and tank berms (Engineer Systems Handbook 1997, 15).

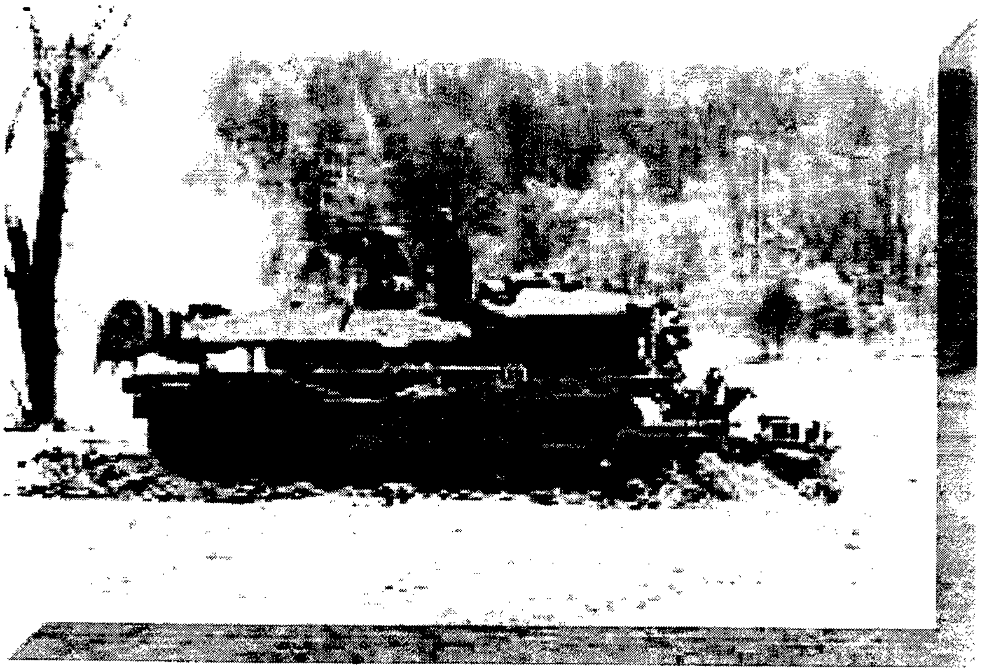

Figure 15. Grizzly

The HE-Hornet (HE-hand emplaced) will be employed in both offensive and defensive operations and in both tactical and operational level roles. In the close battle, combat engineers, maneuver forces under Engineer supervision, and at extended ranges by Special Operations Forces and Rangers, will emplace HE-Hornet. Hornet gauntlets, a series of randomly spaced clusters of three to six Hornets, will be employed along high-speed avenues of approach to disrupt and attrit the enemy. Hornet area disruption obstacles, consisting of twenty Hornets employed in a "X" pattern across a grid square, will disrupt and attrit the enemy as he moves cross-country prior to the start of the direct fire battle. When employed deep, Hornet will disrupt a threat commander's operational tempo by attacking his follow-on forces, logistics and C2, by denying key terrain such as approaches to bridges or river crossing sites, and by selectively attacking high-value targets, such as Tactical Ballistic Missile (TBM) launchers (Engineer Systems Handbook 1997, 20).

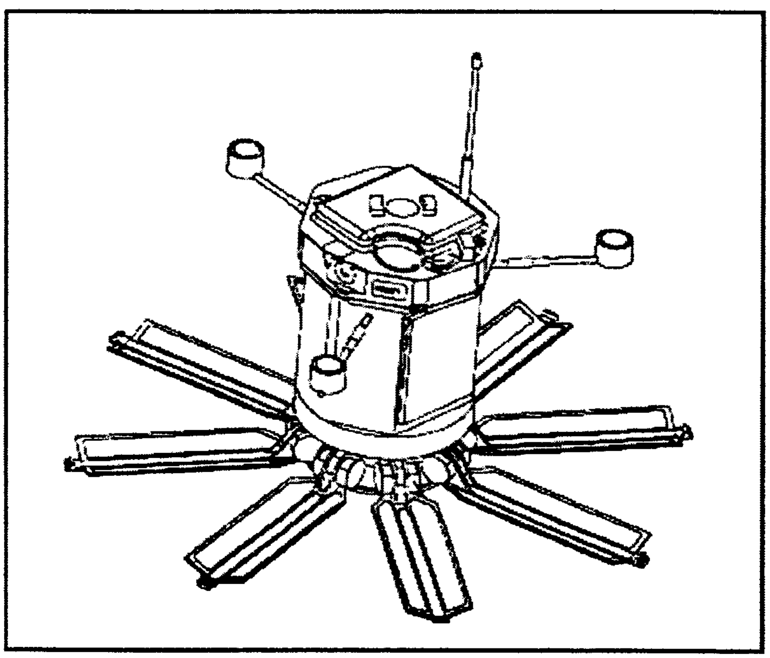

Figure 16. Hornet

Conclusions

In conclusion, both Armies of Excellence and Force XXI engineer capabilities provide adequate protection for the force. The Army of Excellence countermobility capabilities was all maintained and controlled at the divisional brigade. However, Army of Excellence capabilities did not have the extensive scatterable mine capability which Army Force XXI offers. The drawback of having only scatterable mine capability within the brigade, is the required coordination with echelons above division engineer support required to emplace conventional mines. Additionally, coordination will be required for release authority to execute scatterable mine systems. The authority to release scatterable munitions is the corps commander, who can delegate to the divisional commander.

Finally, echelons above division engineers will require additional time to mobilize into sector and adapt to the maneuver commander optempo for the current situation.

The following key points can be made as the force transitions from the Army of Excellence to the Army Force XXI force structure:

1. Nonorganic engineers commanding and controlling divisional engineers--awkward battlefield chemistry--and competence levels of Reserve Component engineers.

2. Reduced number of personnel equals reduced capability to emplace conventional (not mines) obstacles. Reliance on echelon above the division engineers to do this is problematic since they may not show up until much later.

3. Logistics of FASCAM-very costly, technology dependent munitions.

4. Mine warfare systems are flexible. Compared with the costs of other weapon systems, mines are efficient and effective.

Additional Background

"Any mine that is hand laid and requires manual arming is a conventional mine" (FM 20-32 1992, 1-1). Conventional mines offer four advantages over the scatterable mines in the U.S. inventory. The first is that once they are emplaced and armed, conventional mines provide a permanent, lethal effect. Second, the variety of fuze and warhead combinations available allows one to create tailored killing effects. Third, their manual deployment permits one to lay them in specific controlled patterns (including burial). Finally, the deploying unit can recover and reuse conventional mines unless they have fit the mines with antihandling devices (AHDs).

Conventional mines also have weaknesses. Manual mine deployment is both time and labor intensive, two commodities that are usually scarce on a battlefield. For example, it took over three months to lay the 400,000 mines (2700 antipersonnel and 2,400 antitank mines per mile) that went into the defense of the Kursh Salient in 1943. The fact that one can recover conventional mines, listed above, is also a weakness. Once one emplaces the mine, anyone that knows how can recover them. Thus, a unit that employs conventional mines runs the risk of having a savvy enemy take and then use their own mines against them. Despite these shortcomings, the Army recognized the tactical value of conventional mines and produced several types to provide itself with a wide variety of land mine capabilities.

"Any mine in the U.S. inventory that is delivered by artillery, aircraft, vehicle, or ground dispenser system is a scatterable mine" (FM 20-32 1992, 6-1). Scatterable mines offer three advantages over conventional mines. First, they afford U.S. commanders a means of deploying mines in areas that they do not control such as enemy held or containment terrain. Second, scatterable mines can be deployed quickly compared to conventional mine types. It takes an experienced engineer squad about ten hours to lay in a 300-meter long conventional minefield with a 0.5-mine per meter linear density. Linear density is the number mines one would encounter along any one-meter wide path straight through the minefield. On the other hand, one soldier with a Volcano mine dispenser system can deploy a similar minefield (227 meters long and 0.86 mine/meter linear density) in minutes.

Finally, scatterable mines offer commanders increased tactical flexibility. Since all scatterable mines in the U.S. inventory feature timed self-destruct mechanisms, a commander's scatterable mine obstacles do not become permanent impediments to his future maneuver. These characteristics make scatterable mines very attractive weapons but, like all weapons, they have limitations.

Scatterable mines have four main limitations. First, they are always surface laid so they can only produce a surprise effect in limited visibility situations. Second, they come with fix fuzed-warhead combinations so they cannot produce the same variety of killing effects that conventional mines can. Third, their automatic self-destruction feature makes them unsuitable for long term or permanent effect situations (fifteen days is the longest duration for an U.S. scatterable mine). Lastly, the random nature of scatterable mine deployment prevents tailored emplacement or exact mine location recording. This final limitation is at the heart of why scatterable mines of all types are specifically included in the Convention on Prohibitions or Restrictions on the use of Certain Conventional Weapons (CCW) and remain a target for future banning. Limitations or not, the Army uses a wide variety of scatterable mines.

Currently, the engineer community perception of countermobility requirements for Army Force XXI will primarily be provided from echelon above division (EAD) engineer units. With the Army Force XXI design being more lethal and more agile, the force will be oriented toward offensive operations. The projected Army Force XXI divisional engineer structure maintains minimal digging and dismounted sapper capabilities. The divisional (organic) engineers will have only Volcano mine systems to support limited hasty defensive operations.

There are two types of Volcanos, ground and air, which the divisional engineer will employ on the digitized battlefield. Both ground and air Volcano systems share the same characteristics with the exception of their delivery system. M548 (Ammunition Carrier) or a 5-Ton Truck can deliver the ground system. The air Volcano will be mounted on and employed by the UH-60 helicopter.

Additionally, the capability to employ additional countermobility obstacles on the digitized battlefield will reside with the Army Reserve and the National Guard engineer units. The Army Reserve and National Guard engineer units have the equipment and the personnel capability to execute constructed and preconstructed obstacles.

Command and control on the future and current digitized battlefield will be a challenge with the absence of the engineer brigade headquarters. The Army of Excellence engineer brigade headquarters controlled all engineer effort within the division's battlespace with its organic engineers. When additional engineers were required, an engineer group was activated to command and control and provide a buffer between the active and reserve component.

Likewise, with the Army Force XXI engineer force structure less their organic brigade headquarters, planning, executing, and command and control of countermobility obstacles (of all types) on the Force XXI battlefield will require coordination both vertically and horizontally. Coordination will have to be made in advance to maintain the tempo the Force XXI engineers will provide for the maneuver forces.

The integration of EAD and reserve component engineers into the battle must be included with Army Force XXI division engineer training at every opportunity, such as warfighters, combat training center rotations, and during the DCX. The Engineer School is developing new strategies to assist Army Force XXI engineers, including Classroom XXI distant-learning capabilities, new training simulators, and digital doctrine and training products.

The Army Force XXI division has consolidated CSS for armor, infantry, and engineer battalions. In the Army of Excellence design, engineer support was organic to the engineer brigade. The basis for Army Force XXI consolidation is the situational understanding of the CSS status of each unit. Army Force XXI divisional engineer line companies will receive CSS support (less medical) from the engineer support platoon of the Brigade Support Company (BSC). EAD engineers operating in the Army Force XXI division area will continue to receive support from an appropriate EAD CSS unit, such as a corps support battalion. Although centrally located within the maneuver brigade CSS umbrella, logistical support and haul requirements will require accurate and timely requisitioning of required support.

Conclusion

In summary, The Army of Excellence engineer design seemed to have solved all the problems from World War II and Vietnam. With the large number of engineers present on the battlefield during World War II, a corresponding division-level command and control structure was required. Post-World War II recommendations indicated that an "engineer regiment is the optimal division level command and control organization for the division" (Final Report Chief Engineers ETO 1946, 135).

The Army Force XXI has reduced the organic engineer regiment to a colonel's staff position with a small supporting staff to command and control the same potential engineer force. This can put the engineer force and the division at risks, requiring additional time to stand up an engineer group. In the Army of Excellence, the engineer brigade was already present and immediately took charge of additional engineer units while simultaneously standing up an engineer group to command and the additional engineer units. Only time will tell whether or not the Army Force XXI design is truly effective.

In summary, the new Army Force XXI engineer current design will support a more agile and more lethal maneuver force during offensive operations. However, defensive operations or the countermobility effort that will be required to support a more lethal, more agile, and smaller force will continue to be challenge as we integrate Reserve Component and National Guard forces into the active force structure. With the reintroduction of the Engineer Brigade Headquarters, possessing a more responsive and robust command and control element that will have the capability and personnel to sustain additional engineer units on the digitized battlefield can reduce this potential shortfall.

The Army Engineer School continues to stay in the forefront with the standup, training, and validation of the Army Force XXI division design. Insights gleaned will be used to ensure that engineers remain relevant with future redesign efforts.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this section is to answer the research question: Has the United States Army's transition from Army of Excellence to the new Army Force XXI design caused a potential countermobilty shortfall in its quest to produce a force projected mobile agile force?

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Command and control on the future and current digitized battlefield will be a challenge with the absence of the engineer brigade headquarters. The Army of Excellence engineer brigade headquarters controlled all engineer effort within the division's battlespace with its organic engineers. When additional engineers were required, an engineer group was activated to command and control and provide a buffer between the active and reserve component.

Likewise, with the Army Force XXI engineer force structure less their organic brigade headquarters, planning, executing, and command and control of countermobility obstacles (of all types) on the Force XXI battlefield will require coordination both vertically and horizontally. Coordination will have to be made in advance to maintain the tempo the Force XXI engineers will provide for the maneuver forces.

The integration of EAD and reserve component engineers into the battle must be included with Army Force XXI division engineer training at every opportunity, such as warfighters, combat training center rotations, and during the DCX. The Engineer School is developing new strategies to assist Army Force XXI engineers, including Classroom XXI distant-learning capabilities, new training simulators, and digital doctrine and training products.

The Army Force XXI division has consolidated CSS for armor, infantry, and engineer battalions. In the Army of Excellence design, engineer support was organic to the engineer brigade. The basis for Army Force XXI consolidation is the situational understanding of the CSS status of each unit. Army Force XXI divisional engineer line companies will receive CSS support (less medical) from the engineer support platoon of the Brigade Support Company (BSC). EAD engineers operating in the Army Force XXI division area will continue to receive support from an appropriate EAD CSS unit, such as a corps support battalion. Although centrally located within the maneuver brigade CSS umbrella, logistical support and haul requirements will require accurate and timely requisitioning of required support.

Conclusion

In summary, the Army of Excellence engineer design seemed to have solved all the problems from World War II and Vietnam. With the large number of engineers present on the battlefield during World War II, a corresponding division-level command and control structure was required. The post-World War II recommendations indicated that an "engineer regiment is the optimal division level command and control organization for the division" (Final Report Chief Engineers ETO 1946, 135).

The Army Force XXI has reduced the organic engineer regiment to a colonel's staff position with a small supporting staff to command and control the same potential engineer force. This can put the engineer force and the division at risks, requiring additional time to stand up an engineer group. In the Army of Excellence, the engineer brigade was already present and immediately took charge of additional engineer units while simultaneously standing up an engineer group to command and the additional engineer units. Only time will tell whether or not the Army Force XXI design is truly effective.

In summary, the new Army Force XXI engineer current design will support a more agile and more lethal maneuver force during offensive operations. However, defensive operations or the countermobility effort that will be required to support a more lethal, more agile, and smaller force will continue to be challenge as we integrate Reserve Component and National Guard forces into the active force structure. With the reintroduction of the engineer brigade headquarters, possessing a more responsive and robust command and control element that will have the capability and personnel to sustain additional engineer units on the digitized battlefield can reduce this potential shortfall.

The Army Engineer School continues to stay in the forefront with the standup, training, and validation of the Army Force XXI division design. Insights gleaned will be used to ensure that engineers remain relevant with future redesign efforts.

Countermobility doctrine assigns mine warfare four major tasks: the disruption of enemy formations and control, the canalization of enemy forces, the protection of friendly forces from enemy assault, and the attrition on enemy personnel and equipment.

Our Army Force XXI will require countermobility capabilities fitted to our operational concepts and effective against an array of enemy capabilities.

The Army Force XXI Engineer Utilization Survey administered to Combat Engineers in CGSOC class of 2000 concludes:

1. It is essential for current maneuver forces to retain a robust countermobility capability.

2. For the foreseeable future (digitized battlefield), it is essential for maneuver forces to retain a robust countermobility capability.

3. The U.S. Army does not focus adequate research on countermobility in Force XXI operations as needed.

4. The U.S. Army does not focus adequately on countermobility in Force XXI operations as needed.

5. Due to the increased dispersion of units across the battlefield of the future, Force XXI digitized units will require more of a countermobility capability than current units.

6. A very small percentage (six percent) of combat engineers have served in an Army Force XXI digitized division or brigade.

7. A large percentage (seventy-three percent) of combat engineers has served in a maneuver brigade combat team.

In addition to the administered survey and discussion of countermobility relevance, several other key points are worth noting:

1. The scatterable mines in our inventory all have a finite life, which makes them unsuitable for long-term emplacement. There is no doubt that the U.S. will develop a technology-based solution to this problem. What does remain uncertain, however, is the world's reaction to the solution.

2. The integration of EAD and reserve component engineers into the battle must be included with Army Force XXI division engineer training at every opportunity, such as warfighters, combat training center rotations, and during the DCX.

3. Without the brigade headquarters, planning, executing, command and control countermobility obstacles (of all types) on the Force XXI battlefield will require coordination both vertically and horizontally for additional engineers.

Recommendations

As stated earlier, this thesis has only briefly analyzed the development of countermobility doctrine, equipment and capabilities of the Army of Excellence and Army Force XXI. Further research in countermobility support towards maneuver is needed in the following areas:

1. Compare and contrast Army of Excellence versus Army Force XXI leader development.

2. Compare and contrast Army of Excellence versus Army Force XXI unit training.

3. Conduct a detail analysis of the development and capabilities of the Grizzly (formally M1 Breachers).

4. Determine what changes, if any were made in countermobilty doctrine, equipment, organization, and training in the interim period of Army Force XXI and Army After Next (year 2025).

5. Evaluate countermobility support of combined arms, Army Force XXI operation at the U.S. Army Training Center (National Training Center-NTC, Joint Readiness Training Center-JRTC, and others).

Army Force XXI operations envisage high operational tempo and decentralized operations.

Mine warfare, however, has substantially developed in ways contributing to both the components of lethality and uncertainty that make minefields effective obstacles.

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